

**Asarco East Helena Smelter
2008 Interim Measures
Work Plan Addendum**

**Demolition Foot Print Exposed Areas
Soil Sampling, Excavation, and
Confirmatory Sampling Work Plan
And
Blast Furnace Flue and Monier Flue
Cleaning, Demolition, and
Soil Sampling Work Plan**

**Prepared by:
ASARCO LLC**

February 2008



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ASARCO EAST HELENA SMELTER
2008 INTERIM MEASURES WORK PLAN ADDENDUM
DEMOLITION FOOT PRINT EXPOSED AREAS SOIL SAMPLING,
EXCAVATION, AND CONFIRMATORY SAMPLING WORK PLAN
AND
BLAST FURNACE FLUE AND MONIER FLUE CLEANING,
DEMOLITION, AND SOIL SAMPLING WORK PLAN

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ASARCO EAST HELENA SMELTER
2008 INTERIM MEASURES WORK PLAN ADDENDUM

DEMOLITION FOOT PRINT EXPOSED AREAS
SOIL SAMPLING, EXCAVATION, AND CONFIRMATORY
SAMPLING WORK PLAN

AND

BLAST FURNACE FLUE AND MONIER FLUE CLEANING,
DEMOLITION, AND SOIL SAMPLING WORK PLAN

1.0 INTRODUCTION

On May 5, 1998, ASARCO LLC (Asarco) and the United States Environmental Protection Agency (EPA) entered into a Consent Decree (RCRA Consent Decree, U.S. District Court, 1998) to initiate the corrective action process in accordance with the Resource Conservation and Recovery Act (RCRA) and the Clean Water Act (CWA). As part of the RCRA Consent Decree, Asarco prepared several site investigation documents including:

- RCRA Current Conditions/Release Assessment (CC/RA) (Hydrometrics, 1999a);
- Interim Measures Work Plan, East Helena Facility (Hydrometrics, 1999b);
- RCRA Facility Investigation (RFI) Work Plan (Hydrometrics, 2000); and
- Phase I RCRA Facility Investigation Report (Asarco Consulting Inc. (ACI) 2003, revised 2005).

A complete listing of RCRA Consent Decree documents is contained in the Phase I RCRA Facility Investigation (RFI) report.

As part of the RCRA Consent Decree, several interim measures were implemented for groundwater between 1999 and 2001. These earlier interim measures (IM) performed as part of the RCRA Consent Decree are discussed in Section 1.3 of the Phase I RFI report.

In May 2002, a RCRA Interim Measures Work Plan Addendum (IMWPA) was prepared (Hydrometrics, 2002). The 2002 IMWPA addressed groundwater in the intermediate aquifer within the City of East Helena and down-gradient residential groundwater supplies north of the Asarco Plant site. These interim measures are discussed in Section 1.2.1.3 of the IMWPA.

1.1 MONTANA CONSENT DECREE AND ADMINISTRATIVE ORDER ON CONSENT - CLEANING AND DEMOLITION PROGRAM

On February 15, 2005, Asarco and Montana Department of Environmental Quality (Department) entered into a Consent Decree to resolve alleged violations of the Montana Hazardous Waste Act and Montana Administrative Code. This 2005 Consent Decree required Asarco to develop and to implement yearly Work Plans designed to remove, store, and properly dispose of or recycle all remaining hazardous waste and recyclable materials from identified process units located within the East Helena Plant.

1.1.1 2006 Cleaning and Demolition Work

Under the 2005 Consent Decree, Asarco prioritized the cleaning and demolition of the process units located in the sinter plant during calendar year 2006. The scope of this cleaning and demolition project was referred to as Phase I. In February and March 2006, Asarco submitted a draft and revised 2006 Work Plan for this project. The Department approved the Work Plan on March 17, 2006.

On July 14, 2006, Asarco submitted a second revised 2006 Work Plan. This Work Plan expanded the cleaning and demolition of the process units within the East Helena Plant to include Phase I, II and III sites. The submittal described the cleaning and demolition of the following areas.

- PHASE I - Sinter plant conveyor gallery, sinter building, sinter crushing circuit, sinter returns tower, agglomerator building, coke hopper, sinter hopper, and ventilation ducting.

- PHASE II - Laboratory, dross building, bullion casting, speiss granulating pit, speiss loadout, blast furnace flue (from the dross building to the No. 1 blast furnace), and north end of blast furnace building.
- PHASE III - Sinter plant baghouse, hot Cottrell, acid plant scrubbers, and mist precipitator building.

The 2005 Consent Decree expired on December 31, 2006. The cleaning and demolition activities outlined in the 2006 Work Plan were completed before December 31, 2006.

1.1.2 2007 Cleaning and Demolition Work

On October 2, 2007, Asarco and the Department entered into a 2007 Administrative Order on Consent to continue Asarco's cleaning and demolition program previously established under the 2005 Consent Decree. The 2007 Administrative Order on Consent requires Asarco to develop and to implement yearly Work Plans for calendar years 2007 - 2012 to remove, store and properly dispose of or recycle all remaining hazardous waste and/or secondary material located in the process units, pollution control devices, and storage units and other identified areas of the facility. On May 18, 2007, Asarco submitted to the Department the 2007 Cleaning and Demolition Work Plan. On June 13, 2007, the Department tentatively approved the Work Plan. Asarco had anticipated beginning construction of the Corrective Action Management Unit (CAMU) Phase 2 Cell in the spring of 2007. However, approval of the CAMU Phase 2 Cell was not obtained from EPA early enough to complete the entirety of the scheduled cleaning and demolition work as presented in Asarco's May 18, 2007 submittal.

On August 13, 2007, Asarco submitted to the Department the August 2007 Cleaning and Demolition Work Plan that narrowed the scope of the 2007 cleaning and demolition project to areas in close proximity to the proposed speiss-dross area slurry wall. The areas cleaned and demolished under both the 2005 Consent Decree and 2007 Administrative Order on Consent are shown on Figure 2-1 and Exhibit 1. With the exception of the Thaw House, the areas where cleaning and demolition was conducted in 2007 focused on structures that

needed to be removed to provide equipment access for construction of a slurry wall in the speiss-dross area. As illustrated in Figure 2-1 and Exhibit 1, the structures that were cleaned and demolished to accommodate equipment access for construction of the slurry wall are listed as follows:

Phase IV, Stage 1

- Contractor's Lunchroom
- Highline Railroad
- Storage Garage
- Former Speiss-Dross Plant Baghouse & 200-Foot Stack
- Portions of the Blast Furnace Building
- Contractor's Change Room
- Main Office
- Main Natural Gas Valve House
- Charge Building
- Thawhouse

1.2 DEMOLITION FOOTPRINT EXPOSED SOIL SAMPLING, EXCAVATION, CONFIRMATORY SAMPLING WORK PLAN - SCOPE AND OBJECTIVES

EPA has requested the submittal of a work plan that addresses site-wide soil sampling, excavation, and confirmation sampling in remaining exposed areas (unpaved soils) on the site that are scheduled for cleaning and demolition activities. To address this, on May 30, 2007, Asarco submitted to EPA the 2007 Interim Measures Work Plan Addendum, Blast Furnace Flue and Monier Flue Cleaning, Demolition, and Soils Sampling Work Plan (ASARCO LLC, 2007a). On September 25, 2007, Asarco submitted to EPA the 2007 Interim Measures Addendum - Speiss-Dross and Thaw House Areas Soil Sampling, Excavation, Confirmatory Sampling, and Interim Capping Work Plan (ASARCO LLC, 2007b).

During 2007, Asarco implemented the cleaning, demolition, and interim capping portions of the Speiss-Dross and Thawhouse Areas Soil Sampling, Excavation, and Confirmatory Sampling, and Interim Capping Work Plan to facilitate slurry wall construction in the speiss-dross area. In addition, the cleaning, demolition, and interim capping portions of this Work Plan in the thaw house area and soil sampling at the Main Office and Thaw House was conducted. All proposed actions outlined in the Blast Furnace Flue and Monier Flue Cleaning, Demolition and Soil Sampling Work Plan were postponed pending EPA approval.

This 2008 IM Work Plan Addendum merges the components of these two previously submitted Work Plans.

The objectives of this 2008 IM Work Plan Addendum are:

- Discuss existing soil data obtained from sample sites adjacent to remaining structures in the Speiss Dross and the Thawhouse areas.
- Identify and catalog exposed areas within demolition footprint areas.
- Outline the soil sampling, excavation, and confirmatory sample protocols and procedures for assessment of exposed portions within the demolished areas.
- Present the locations that will require interim capping or permanent cover.
- Describe cleaning techniques, dust control activities and demolition procedures for the blast furnace flue and Monier flue including:
 - Pre-demolition cleaning activities
 - General demolition procedures for steel, and for concrete/masonry
 - Material stockpiling
 - Debris transportation
 - Final cleaning action
 - Maintenance
 - Site security
 - Storm water pollution prevention
 - Dust control
- Present the schedule for plan implementation.

2.0 DEMOLITION FOOT PRINT EXPOSED AREA SOIL SAMPLING, EXCAVATION AND CONFIRMATORY SAMPLING

The remaining structures that are scheduled to be cleaned and demolished include:

Phase IV, Stage 2

- Blast Furnace Flue
- Acid Plant Cooling Towers
- 400' D&L Stack
- Acid Plant Contact Section
- Blast Furnace Baghouse
- Ore Unloading Bins
- Crushing Mill
- Pump Tank Building
- Acid Plant Shop
- Truck Loading & Spray Dryer Building
- Sand Filters
- 200' Acid Stack
- Monier Flue
- 425' Blast Furnace Stack
- Sample Mill
- Auto Shop
- Main Blower Building
- Ringling Dust Building

Alternate A and Alternate B

- Highline Railroad Remainder
- Blast Furnace Office
- Power House
- Blast Furnace Heat Exchanger
- Machine Shop
- Direct Smelt Building
- Breaking Floor
- Masons Shop
- Motor & Paint Shop
- Paint Storage Building
- Meeting Room
- Locomotive Crane Shed
- Blast Furnace Lunchroom
- Pump House
- Blacksmith Shop
- Carpenter Shop
- Abandoned Breaking Floor
- Sinter Stockpile Building
- High Lead Welding Shop
- Oil HS
- Refractory Storage
- Zinc Plant O₂ Building

In 2007, EPA notified Asarco and the Department that cleaning and demolition of the blast furnace flue and Monier flue was to be conducted in accordance with the RCRA Consent Decree. As a result, the cleaning and demolition procedures for these flue systems are included in Section 3 of this 2008 IM Work Plan Addendum. The exposed soils sampling procedures for the flues, as well as the other areas of exposed soils are addressed in this section (Section 2).

Figure 2-1 and Exhibit 1 illustrates the seven (7) cleaning and demolition structure footprints, exposed soils sample areas. The proposed soil sample locations are also shown on Figure 2-1 and Exhibit 1.

2.1 EXISTING SOIL DATA

Surface and sub-surface soil data were presented in the Phase I RFI, Appendix 7 (ACI, 2003). Relevant soil data are included in Appendix A and summarized in Tables 2-1 through 2-10 of the Work Plan. The data include samples collected at surface soil sites, sub-surface boreholes, test pits, and monitoring wells.

Figure 2-2 shows arsenic profile data across the plant site. The profiles illustrate that arsenic is generally elevated in surface and near surface soils throughout the plant area. Arsenic generally decreases with depth.

The site wide soil summary statistics for the surface soils are shown in Table 2-1. The source of these data is the 2003 Phase I RFI (ACI, 2003). This table contains all RFI sample locations including:

- Unpaved on-plant areas
- Unpaved off-plant areas
- Former lower ore storage areas
- Former upper ore storage areas and
- Rail corridor areas.

The site wide soils summary statistics for unpaved (exposed) on-plant site areas are shown in Table 2-2. This soil sample group represents most of the demolition exposed soils sample areas. Section 2.2.3 describes the manner in which the site wide unpaved (exposed) on-plant site area soil arithmetic mean concentrations will be used to define “hot spot” soil removal criteria for exposed soils within demolition footprint areas. Existing soil data near demolition foot print areas are discussed in Section 2.3.1 through 2.3.6.

2.2 EXPOSED SOIL AREA SAMPLING

As described in Section 2.0, Figure 2-1 and Exhibit 1 show the location of cleaning and demolition structures and exposed soil sample areas. As part of the 2007 work, exposed soil areas within or adjacent to cleaning and demolition footprint areas were identified in the field and mapped. Figure 2-1 and Exhibit 1 show identified exposed soil areas.

2.2.1 Post Cleaning Exposed Soil Identification and Cataloging

Once cleaning and demolition is complete (see Section 3 of this Work Plan) and the debris has been removed from the cleaning and demolition work plan areas, a final inspection of the demolished structure footprint will be conducted. A visual survey will be conducted to catalog any area within the structure footprint where asphalt or concrete is not present and underlying soils may have been exposed to dust or elevated metal containing materials. The survey will also document the condition of asphalt or concrete within the structure and footprint. The documentation will include a written description that is supported with photographs. All exposed soil areas and broken or severely cracked asphalt or concrete areas will be mapped and recorded on plan views of the demolished structures.

2.2.2 Exposed Soil Area Sampling Methods

If exposed soil areas are encountered within the cleaning and demolition footprints, the exposed soil area will be sampled and analyzed for the following indicator parameters: arsenic, copper, cadmium, lead, zinc and selenium, and supplemental parameters: aluminum, antimony, barium, beryllium, chrome, cobalt, iron, manganese, mercury, nickel, silver thallium and vanadium using wet chemistry standard EPA methods. The soil sample collection and analytical matrix is summarized in Table 2-3. Based on known exposed soil areas, the proposed soil sample sites were identified and shown on Figure 2-1 and Exhibit 1.

A total of five surface (0-4 inch increment) soil samples will be collected from each sample site in identified exposed soil areas and composited into one representative sample of the area. Surface soil samples will be collected using hand tools (hand shovels, trowels, or hand augers). The samples will be stored in ziploc bags and archived for analysis. All analytical work will be conducted before the 6-month holding time limit for metals. The location of

each soil sampling site will be cataloged using sample numbers and GPS coordinates. Sites with visually obvious dust or ones that exceed the numerical criteria described in Section 2.2.3 and in Table 2-3 of this Work Plan will be considered candidates for sub-surface soil excavation. The sampling Standard Operation Procedures (SOPs), analytical parameters, and methods are summarized in Table 2-3. For convenience, the relevant SOPs from the IM and RFI work plans are contained within Appendix B of this Work Plan.

Surface soil samples will be collected from exposed soil areas using the same techniques and procedures used for Interim Measures (IM) and RCRA Facility Investigation (RFI) activities, as described in the IM and RFI Work Plans (Hydrometrics, 1999b and Hydrometrics, 2000).

2.2.3 Exposed Soil Removal Criteria and Confirmatory Sampling

Metal concentrations in former processing areas may range in percents (10,000 mg/kg to 200,000 mg/kg). Initial soil sample results in this concentration range are indicative of remaining processing dust, materials residuals, or impacted soils. Where unpaved soil areas within demolition structure footprints have been exposed to dust or elevated metal containing materials, excavation of dust material residuals and impacted soils will be conducted. As excavation occurs, soil samples will be collected at the depth intervals shown in Table 2-3 and analyzed for the indicator parameters arsenic, cadmium, copper, lead, zinc and selenium. Samples collected during excavation will be either field tested using a portable X-Ray Fluorescence (XRF) analyzer using procedures based on EPA Method 6200 (EPA February 2007) or analyzed using standard EPA wet chemistry methods. The portable XRF will be used in its “point and shoot” mode as a field screening tool, not as a definitive analytical tool. The purpose of using the XRF will be to make rapid decisions in the field whether to advance excavation or collect final samples for definitive analysis using standard EPA wet chemistry methods. The advantage of using a field XRF is rapid turnaround time and the ability to make decisions on excavation limits as the work is being conducted. Conversely, laboratory analysis may result in delays and affect the duration of the excavation effort and its associated costs.

The soil sample collection and analytical matrix is summarized in Table 2-3. As the table shows, initial and final samples will be analyzed for indicator parameters (As, Cd, Cu, Pb, Se, and Zn) and for supplemental parameters (Al, Sb, Ba, Be, Cr, Co, Hg, Fe, Mn, Ni, Ag, Tl, V). The final sample increment will also be analyzed using the Synthetic Precipitation Leachate Procedure (SPLP).

The criteria for excavation are as follows:

- Excavate obvious dust, elevated metal containing material, or impacted soil based on visual observation. Ore processing dust is generally very fine grained and gray to black in color. This generally contrasts with native soils which can be fine to coarse grained, typically show traces of sand and gravel, and are generally a tan or brown color.
- Exposed soils or materials within demolished structure footprints that exceed the site wide unpaved (exposed) on-plant site areas soil arithmetic mean concentrations for the 2 - 4 foot interval as shown on Table 2-2 and summarized in Table 2-3 will be excavated. Because soil concentrations are elevated throughout unpaved areas on the plant site, the arithmetic mean concentrations for site wide unpaved (exposed) on-plant site area soils in the 2 - 4 foot interval has been selected as a relatively conservative target for soil removal. Soils will be excavated until:
 - The values for arsenic, copper, cadmium, lead and zinc are below the arithmetic mean as shown in Table 2-2 and summarized in Table 2-3, or
 - The practical excavation limit of excavation equipment is reached (typically 12 to 15 feet), or
 - The water table is encountered.
- Following excavation, samples collected from the deepest interval sampled will be analyzed for indicator parameters and supplemental parameters using wet chemistry standard EPA methods. The final sample increment will be retained and analyzed for SPLP.

Sub-surface soil samples will be collected directly from the soil excavation equipment bucket in the following increments until excavation depth criteria described above and summarized in Table 2-3 are met. Sub-surface soil increments are: 4 - 12", 1 - 2', 2 - 4', 4 - 6', 6 - 8', 8 - 10', 10 - 12', and 12 - 15', as necessary. One soil sample will be collected directly from the backhoe bucket for each increment within an identified exposed soil sample area. Excavation and sampling will continue using the procedure described above until numeric criteria or practical excavation limits are met.

Sub-surface soil samples will be collected from exposed soil areas using the same techniques and procedures used for Interim Measures (IM) and RCRA Facility Investigation (RFI) activities, as described in the IM and RFI Work Plans (Hydrometrics, 1999b and Hydrometrics, 2000). Samples will be stored in ziploc bags and archived until the project is complete, or if the sample is used for wet chemistry analysis. If any future analytical work will be conducted, it will be completed before the 6-month holding time limit for metals.

2.3 DEMOLITION FOOT PRINT EXPOSED SOIL SAMPLE AREAS

2.3.1 Existing Soil Data from Former Speiss-Dross Area and Thaw House Area (Area 1)

The location of the former Speiss-Dross and Thaw House Area is shown on Figure 2-1 and Exhibit 1 (Area 1). Arsenic and metals data from surface and sub-surface soil samples collected from monitoring wells and surface soil sample sites adjacent to or near the former speiss-dross area and near the thaw house are contained in Appendix A and are summarized on Table 2-4. Sample site locations are shown on Figure 2-1. Unpaved soils site (UPS-SS13) and monitoring well soil sample results (DH-13, DH-26, DH-27, DH-30, DH-35 and DH-36) show elevated metals in near surface soils (0 to 6 feet). These elevated readings generally decrease with depth below the five (5) or six (6) foot interval. Unpaved soil sample sites (UPS-SS06, UPS-SS08, LOS-SS14, LOS-SS16A and LOS-SS16B) and monitoring well DH-66 (see Figure 2-1) show soils in the thaw house area that contain elevated metals in surface soils but concentrations decrease significantly below the four (4) foot depth interval.

A comparison of the speiss-dross and thaw house area surface and sub-surface soil data (Table 2-4) with the site wide summary statistics for surface soils (Table 2-1) and the site wide unpaved (exposed) on-plant site areas soil statistics (Table 2-2) shows, in general, soils are occasionally above the site wide averages but less than maximum recorded values for the entire site. In general, the soil metal concentration in areas adjacent to the speiss-dross and the thaw house are lower than the arithmetic mean surface soil concentrations for all soil sample areas and for unpaved (exposed) on-plant areas. The one exception was surface soils for DH-13, which is about 200 feet north of the speiss-dross area (see Figure 2-1). DH-13 surface soils (0 - 4 inch interval) samples contained the highest measured concentrations for arsenic, cadmium and lead, compared to other unpaved (exposed) area sample sites.

Table 2-5 shows the results of the soil samples collected within the thaw house demolition footprint area and within the main office footprint area in the fall of 2007. In order to facilitate temporary capping, these areas were sampled to a maximum depth of 15 feet and submitted to the laboratory for analysis using wet chemistry techniques. The samples were collected and analyzed in accordance with the procedures summarized in Table 2-3 and described in Section 2.2.2 and 2.2.3 above. The analyses show a pattern of elevated soil metals at the surface with decreasing concentrations with depth.

A comparison of sample results (Table 2-5) with the site wide unpaved (exposed) on-plant site areas soil arithmetic mean concentrations (Table 2-2) show the thaw house soils at some locations (sample site TH-3 and TH-4) were above arithmetic mean concentrations for lead and zinc in the 0 - 4" interval. However, three of the five sample sites (TH-1, TH-2 and TH-5) were well below arithmetic mean concentrations for unpaved (exposed) sample sites for all parameters at all sample intervals.

Based on the criteria discussed in Section 2.2.3 and presented in Table 2-3, the surface soil interval (0 - 4") will be removed from soils in the thaw house demolition foot print near TH-3 and TH-4. Using the numeric criteria presented in Section 2.2.3 and Table 2-3, the areas of the thaw house represented by sample sites TH-1, TH-2 and TH-5 would not require soil excavation, since the results for all sample intervals were below the arithmetic mean

concentrations for arsenic, cadmium, copper, lead and zinc in the 2 - 4 foot interval for unpaved sample sites.

Soil samples were also collected from exposed soils within the main office building foot print (see Figure 2-1). Using excavation equipment, soil samples were collected from the main office area to a depth of 15 feet. A comparison of Table 2-5 (Main Office sample site MO-1) with unpaved the site wide unpaved (exposed) on-plant site areas soil arithmetic mean concentrations contained in Table 2-2, shows concentrations in the 0 - 4" increment would require excavation to meet numeric criteria for copper, lead and zinc as described in Section 2.2.3 and presented in Table 2-3. This interval has already been removed as part of the final cleaning and demolition process in the main office building foot print. As part of the final cleaning and demolition process, exposed soils below the main office foot print area were excavated to 6 feet below grade surface. The excavation was filled with slag and a temporary cap was installed to limit the potential for infiltration of precipitation and runoff within the main office foot print area. EPA was notified of these actions in the October 2007 and November 2007 monthly RCRA Consent Decree progress reports.

2.3.2 Existing Soil Data Near the Blast Furnace and Monier Flue Areas (Areas 2 and 3)

The location of the blast furnace flue and Monier flue is shown on Figure 2-1 (Area 2 and 3). Arsenic and metals data from surface and sub-surface soil samples collected from monitoring wells and surface soil sample sites adjacent to or near the blast furnace flue and Monier flue are contained in Appendix A and are summarized on Table 2-6. Sample site locations are shown on Figures 2-1 and Exhibit 1. In general, surface soil sample results (UPS-SS1, UPS-SS2, UOS-SS3 and UOS-SS5) and monitoring well soil sample results (DH-30, DH-46, DH-45, and DH-39 and DH-60) show elevated metals in surface soils (0 to 6 feet) but generally decrease with depth below the six (6)-foot interval. Monitoring wells DH-30, DH-46 and DH-45 are drilled adjacent to the blast furnace flue (see Figure 2-1) and are likely the most representative of soil near this area.

Table 2-1 presents site wide summary statistics for surface soils (2003 Phase 1 RFI (ACI, 2003). A comparison of flue soil data (Table 2-6) with site wide summary soil statistics for

surface soils (Table 2-1) shows, in general, soils adjacent to the flue are often above the site wide summary statistics for surface soils mean concentration but less than maximum recorded values for the site. One exception is UPS-SS1 for the 1 to 2 foot increment, which had a site wide high for copper.

A comparison of the site wide summary statistics for surface soils with Table 2-6 shows that soil adjacent to the blast furnace flue at site UOS-SS3 (see Figure 2-1) had maximum concentrations for all of the metals tested in the 4 inch to 12 inch interval and had maximum concentration values for some of the metals in other tested depths. All results for this location were higher than the averages for soil sample sites in the Upper Ore Storage Area sites. Although surface soils and shallow sub-surface soils (1 to 6 feet) are elevated at these locations, with few exceptions soil concentrations are above arithmetic mean concentrations from corresponding sample intervals unpaved (exposed) on-plant site areas (see Table 2-3 and Table 2-6). The unusually high metal concentrations associated with sample site UOS-SS3 may be a reflection of its locations near a blast furnace flue traffic underpass, which would have been a major traffic route from the Upper Ore Storage Area to the interior of the plant.

Table 2-2 presents the site wide soils summary statistics for unpaved (exposed) on-plant site areas. A comparison of the summary statistics within Table 2-2 shows that flue soil site UPS-SS1, which is located adjacent to the Monier flue (see Figure 1-1), had the highest measured concentrations for cadmium and lead, compared to other unpaved area sample sites. This observation suggests historic spillage near the clean out door areas. The other Monier flue area sample, UPS-SS2 (see Figure 2-1) had relatively low soil concentrations (see Table 2-6) that were below the site wide unpaved (exposed) on-plant site areas soil arithmetic mean concentrations (see Table 2-2). The nearest monitoring well located in close proximity to the Monier flue area is DH-39 (see Figure 2-1). A comparison of soil sample results from DH-39 (see Table 2-6) against the site wide soil summary statistics for unpaved (exposed) on-plant site areas (Table 2-2) shows copper and zinc concentrations above the arithmetic mean concentrations for the 1 - 2 and 2 - 4 foot increments. However, the

concentrations of the remaining metals analyzed (arsenic, cadmium and lead) were lower than the arithmetic means for these sites.

2.3.3 Existing Soil Data Near the Acid Plant Contact Section (Area 4)

The location of the acid plant contact section is shown on Figure 2-1 and Exhibit 1 (Area 4). Arsenic and metals data from surface and sub-surface soil samples collected from monitoring wells and surface soil sample sites adjacent to or near the acid plant contact section are contained in Appendix A and are summarized on Table 2-7. The sample site locations are shown on Figure 2-1 and Exhibit 1. Unpaved soils site (UPS-SS3) and monitoring well soil sample results (DH-40, DH-41, DH-44, and APSD-13) show elevated metals in surface soils (0 to 4 - 6 feet). Monitoring wells DH-40 and DH-44 show a pattern of significant decrease in arsenic and metal concentrations below 4 feet. However, monitoring wells DH-41 and APSD-13 show concentrations of arsenic remain elevated at much deeper levels (20-22 feet) down into the water table. These elevated arsenic concentrations at depth suggests past process water fluid losses associated with historic operation of the acid plant facility.

A comparison of acid plant contact section data (Table 2-7) with the site wide soils summary statistics for surface soils (Table 2-1) and the site wide summary statistics for unpaved (exposed) on-plant site areas (Table 2-2) shows, in general, soils are above the site wide arithmetic mean and the arithmetic mean for unpaved (exposed) soil areas for at least some parameters but less than maximum recorded values for the site.

2.3.4 Existing Soil Data Near the Direct Smelter Building Area and Maintenance Shop Area (Area 6)

The location of the direct smelt building and shop maintenance areas are shown on Figure 2-1 (Area 6) and on Exhibit 1. As the figures show, Area 6 includes structures located east and west of the blast furnace flue. Arsenic and metals data from surface and sub-surface soil samples collected from monitoring wells and surface soil sample sites adjacent to or near the areas are contained in Appendix A and are summarized on Table 2-8. The sample site locations are shown on Figure 2-1 and Exhibit 1.

The unpaved surface soil sites (SS-29 and UPS-SS4) and monitoring well soil sample results (DH-47, and DH-59) show elevated metals in surface soils (0 to 4 feet). Monitoring wells DH-47 and DH-59 show a pattern of significant decrease in arsenic and metals concentrations below 4 feet.

A comparison of surface soil and monitoring well soil data (Table 2-8) with site wide soil summary statistics for surface soils (Table 2-1) and site wide soil summary statistics for unpaved (exposed) on-plant site areas (Table 2-2) shows, in general, soils are above the site wide arithmetic average and near the arithmetic mean for unpaved soil areas for all parameters but less than maximum recorded values for the site. One sample site (UPS-SS4) exhibited the maximum value for lead concentrations in the 0-4 inch increment.

2.3.5 Existing Soil Data Near the Sample and Crushing Mill Areas (Area 5)

The location of the sample and crushing mill are shown on Figure 2-1 (Area 5) and on Exhibit 1. Arsenic and metals data from surface and sub-surface soil samples collected from monitoring wells and surface soil sample sites adjacent to or near the areas are contained in Appendix A and are summarized on Table 2-9. The sample site locations are shown on Figure 2-1 and Exhibit 1.

The unpaved surface soil sites (SS-20, UPS-SS4 and UPS-SS5) and monitoring well soil show elevated metals in surface soils (0 to 4 feet). Monitoring wells DH-22 and DH-43 show a pattern of significant decrease in arsenic and metal concentrations at the 6-8 foot depth increment and at the 8-10 foot increment, respectively.

A comparison of surface soil and monitoring well soil data (Table 2-9) with site wide soil summary statistics for surface soils (Table 2-1) and site wide soil summary statistics for unpaved (exposed) on-plant site areas (Table 2-2) shows, in general, surface soil metal concentrations (0 - 4 feet) are above the site wide arithmetic mean for some parameters, and above the arithmetic mean for unpaved soil areas for all parameters but generally less than maximum recorded values for the site. One sample site (UPS-SS4) had the maximum value lead concentrations in the 0 - 4 inch increment.

2.3.6 Existing Soil Data Near the Former Zinc Plant Shop and Meeting Room Area (Area 7)

The location of the former zinc plant shop and meeting room areas are shown on Figure 2-1 (Area 7) and on Exhibit 1. Area 7 includes structures located on the north edge of the plant facility area adjacent to the slag pile. Arsenic and metals data from surface and sub-surface soil samples collected from monitoring wells and surface soil sample sites adjacent or near the areas are contained in Appendix A and are summarized on Table 2-10. Sample site locations are shown on Figure 2-1.

Soil concentration data from 2 monitoring wells (DH-23 and DH-57) have been collected in the area. Monitoring well soil sample results from DH-23 show elevated metal concentrations to a depth of 8 feet. This well is completed in slag and the metal concentrations reflect typical concentrations of copper, lead, and zinc. In contrast, soil concentrations from monitoring well DH-57 are relatively low.

A comparison of monitoring well soil data (Table 2-10) with site wide soils summary statistics for surface soils (Table 2-1) and site wide soil summary statistics for unpaved (exposed) on-plant site areas (Table 2-2) shows, in general, metal concentrations in DH-23 are generally above site wide concentrations and are above the arithmetic mean for unpaved soil areas for lead and zinc. In contrast, soil metal concentrations from DH-57 were low and well below the site wide and unpaved soil sample site arithmetic means.

3.0 2008 BLAST FURNACE FLUE AND MONIER FLUE CLEANING AND DEMOLITION WORK

The dust cleaning process employed by Asarco during calendar year 2001 was successful in removing the majority of blast furnace flue and Monier flue dust. Minimal amounts of dust remain within the flues, which are primarily confined to inaccessible, overhang areas. The following sections describe remaining cleaning techniques, dust control activities, available and relevant soil data, demolition procedures, post demolition sampling and testing, and post demolition dust and soil removal protocols that will be applied to the blast furnace flue and Monier flue.

3.1 PRE-DEMOLITION CLEANING ACTIVITIES

Pre-Demolition cleaning activities include the following general steps (URS, April 2007):

- Work area preparation
- Initial dry removal of bulk solids and
- Moistening of structure interiors for dust control.

Work area preparation consists of delineating a work area that can be both easily contained and is considered a cohesive unit with like contamination. The blast furnace flue and Monier flue have been defined collectively as a delineated work area (see Area 3, Figure 2-1). Initially, the contractor will remove any remaining accessible bulk solids that remain within the flues. The goal of this task will be to remove any remaining aggregate, dry accumulation of lead, lead dust, lead debris or other associated residues at all accessible areas. This will be accomplished using hand tools and a trailer mounted “Hurricane” vacuum system with HEPA filtration. The removed material will be loaded via air-tight chute into appropriate containers (i.e., double 6-mil mega bags, etc.) and hauled directly to CAMU. This initial removal of solids at ground level will ensure a more effective and more controlled method of demolition and dust control.

Following this removal process, the structure's interior will be pre-wet and moistened. The purpose of this action is to limit the potential for airborne dust during the above grade demolition operation. Pre-wetting operations will be accomplished using water trucks (for a portable water source), hoses, and misting systems. The application of wetting agents will be carefully controlled to avoid accumulation and limit infiltration of water through the floor of the flues. Although it is believed the floors are concrete slabs or masonry, the condition of the concrete or masonry is unknown, and there may be portions of the flue floors that are not paved or covered. As a result, careful water application is necessary to limit the potential for infiltration through the flue floor.

3.2 GENERAL DEMOLITION PROCEDURES

The general cleaning and demolition procedures for the blast furnace flue and Monier flue have been described in the 2007 Cleaning and Demolition Project and CAMU Phase 2 Cell Project Work Plan (URS, 2007). These procedures include cleaning and demolition of the remaining portions of the blast furnace flue and Monier flue (see Figure 2-1). Prior to above grade structural demolition, site inspections will confirm that:

- Pre-demolition decontamination and cleaning are complete and
- Any required interior and exterior asbestos abatement operations are completed.

Pre-demolition decontamination and cleaning are described in Section 3.1 above.

Asbestos abatement methods are also included in the 2007 Cleaning and Demolition Work Plan (URS, 2007). Asbestos mastic is present on some of the blast furnace flue brick. The associate flues and structures will be subject to asbestos abatement activities prior to and during demolition as required. URS has hired an asbestos abatement contractor (IRS Environmental) to perform asbestos abatement activities. Their work procedures and methods are described in Attachment B of the 2007 Cleaning and Demolition Project and CAMU Phase 2 Cell Project Work Plan (URS, 2007) and within Appendix C of this Work Plan.

Any friable and removable asbestos materials will be removed and handed prior to demolition in accordance with the asbestos plan in Appendix C. An exception to this is the asbestos mastic present on some of the blast furnace flue brick. There is no practical and safe way to remove the mastic prior to demolition. The mastic is non-friable and is not considered a potential airborne hazard. In addition, most of the mastic is covered in insulation foam, which is also not practical to remove prior to demolition. As a result, bricks with mastic will be handled using the same procedures as other concrete masonry as described below in Section 3.2.2.

3.2.1 Steel Structure Demolition

Although little or no steel demolition is expected for demolition of the blast furnace flue and the Monier flue, steel structure demolition may be required for portions of the flues that connect with other structures. The approach for steel demolition is described in the 2007 Cleaning and Demolition Work Plan and is described as follows:

The approach to building demolition is to use excavators (track-mounted) equipped with specialty attachments (such as shears, breakers and grapples) to structurally remove, bay by bay, the various structural members. The sequence approach is as follows:

- Each structure will be demolished using excavators with specialized attachments. Each truss frame structure between bays will be lowered and/or dropped to the ground by separating the portion of the tension members on the bottom cord to cause the truss to sag in between two bays.
- The excavator will then separate the remaining tension members of the truss to allow one end of the main truss to become separated from the supporting column.
- The other end (still connected) of the truss will be disconnected. The remaining roof traverse trusses, connecting main truss to main truss shall be removed to allow placement of the main truss behind the equipment for salvage. The remaining portion of the roof attached to the next bay section will be cut allowing for removal. The excavator will then drag the roof

section for stockpiling and separation. This process is repeated for each of the numerous bays within each of the above referenced buildings.

- Steel columns will be cut with a shear at the base, and allowed to fall to the ground.

All material will be staged behind the working areas of the primary excavators, where it will be prepared by additional shears before it is loaded into dump trucks and hauled to the steel staging area just to the north of the Coverall Buildings. Materials will be continuously removed to allow other operations to proceed.

3.2.2 Concrete/Masonry Structure Demolition

Concrete/masonry demolition will constitute the majority of demolition work for the blast furnace flue and Monier flue. This approach is outlined in the 2007 Cleaning and Demolition Work Plan. Although all of the approach may not specifically be applicable to flue demolition, this approach is also described below as follows:

A 100,000 lb excavator (or larger), equipped with a breaker, and a track loader will be utilized for the complete above grade concrete demolition operations of the various concrete and masonry structures. The exterior walls are constructed of either a concrete block material or a brick material. Starting at one end, URS/CWC will commence breaking from the top of the wall down from column to column. Once complete with the exterior wall at the end, URS/CWC will commence the removal of the concrete upper floors slabs within the same constraints as the wall. This process is limited to the first exterior column line. Demolition of any elevated floor slabs and walls will be completed in a top down approach for each individual column line. URS/CWC will break the closest interior columns under the roofs and floor, allowing the individual floor to sag. URS/CWC will work into the building, breaking the sagged slabs and allowing the debris to fall to the ground. As the floor slabs are removed and area is created in front of the equipment, URS/CWC will continue to break interior columns from the top down.

Once complete for that column, URS will repeat the same procedure for the remaining column lines. Utilizing a track loader, the broken concrete debris will be removed and hauled directly to the CAMU.

3.2.3 Demolition Material Stockpiling

Flue demolition debris (consisting of concrete and brick with the majority of flue dust removed) and associated debris from the blast furnace flue and Monier flue will be stockpiled in accordance with procedures outlined in the 2007 Demolition and Cleaning Work Plan, and further described as follows:

As steel structure and concrete demolition is progressing, material will be hauled and stockpiled in the designated Material Staging and Processing areas located within the demolition area footprints. At these locations, both general demolition debris and salvageable metal materials will be sized to meet the requirements of the final disposition location. Once general demolition debris has been segregated and sized, URS/CWC will load and haul into the CAMU. With regards to salvageable metals, URS/CWC will size the material to its requirements and stage the material for eventual loading into railcars and/or trucks for transport to the recycling facility.

3.2.4 Debris Transportation

Demolition debris will be transported using procedures outlined in the 2007 Cleaning and Demolition Work Plan and further described as follows:

URS/CWC understands the critical nature of loading and transporting of waste debris from either temporary storage or demolition areas to the CAMU. Therefore, URS/CWC will take a proactive approach to ensure that the transportation of waste debris does not generate dust or spread waste debris outside the limits of the loading area and the final CAMU placement area. For all demolition debris, as further described below, URS/CWC will utilize water trucks and misting systems to keep debris moist during the demolition and loading process. These two operations will minimize airborne dust during the loading operation and be the first step in prevention during transportation.

URS/CWC anticipates utilizing 25-35 ton rock trucks and/or 10-wheel dump trucks, or a combination thereof, to haul the material to the CAMU. All trucks will be equipped with sealed tail gates that will be closed during times of hauling to ensure that debris is not released outside the limits of the loading and dumping areas. In order to further mitigate dust generation during hauling operations, URS will construct a truck moistening station at the exit of the ASARCO site over to the CAMU site. This station will consist of a scaffolding platform on which personnel will mist water on the loaded debris as a final step before it travels outside the property fence line and across the County road. The spray will add a final moisture barrier/binder to the debris for the short distance to the CAMU. Transport vehicles will be limited to a maximum 10 miles per hour while both on-site and during transport. Limiting speeds will prevent dust from become airborne during transport and will prevent the kick-up of dust due to rolling tire action.

At the CAMU dump area, a water truck will be placed to lightly mist debris and knock down any dust during the dumping and spreading phase of the debris in the CAMU. Use of water will be kept at a minimum. At all times, however, the elimination of dust will be given top priority.

Transport of waste on-site will follow prescribed paths, which will be determined during the course of demolition. Due to the changing nature of the site as demolition of structures progresses, haul routes will require modification. However, once defined, these haul routes will be enforced to create dedicated routes that can be maintained to mitigate dust and debris migration, and prevent any potential spread of contamination. Maintenance of haul routes will be conducted through routine daily inspection to ensure that debris is not being released. Additionally, haul routes will be lightly wet with a water truck on a frequent basis throughout any given day to prevent the generation of dust due to vehicular traffic. URS/CWC will utilize the services of a street sweeper to clean the haul routes of accumulated debris and dust.

This debris and dust sweepings will be dumped on-site and handled as demolition debris for eventual placement into the CAMU.

3.2.5 Final Cleaning Actions

Once demolition is complete and the debris has been removed, a final inspection of the floor foot print of the blast furnace flue and the Monier flue will be conducted. A visual survey will be conducted to catalog any area within the structure footprints where concrete is not present and underlying soils may have been exposed to flue dust or other elevated metal bearing materials. The survey will also document the condition of concrete within the structures and floors. The documentation will include a description and photographs. All exposed soil areas, broken or severely cracked concrete areas will be mapped and recorded on plan views of the demolished structures.

3.2.5.1 Concrete Floor Area Sampling and Cleaning

The final cleaning of concrete covered demolition footprint areas will involve a three-phased approach. First, the concrete footprint will undergo a rough cleaning using conventional scraping and shoveling methods to remove any solid residues that may have accumulated during the demolition process. Second, the concrete footprint will be mechanically swept. The use of a mechanical sweeper will remove surface materials that may not be completely removed using scraping and shoveling techniques. Finally, the concrete footprint will be cleaned using a high-velocity, truck mounted vacuum. This final cleaning method will remove any fine material, particularly along the interfaces between the concrete floor and building columns, fan foundations, and support walls.

3.2.6 Plug and Abandon Underground Piping

Underground piping exists within the footprint in which cleaning and demolition will take place. The underground piping will be plugged and sealed in place. The utility locates will be performed by the URS/CWC and compared with the utility drawings and underground utility information provided by Asarco to identify as many underground utilities as possible. The underground utility map provide by Asarco is included in Figure 3-1. The abandoned underground utilities that will be flow filled is included in Figure 3-2. The utility piping will

be flushed with water and blown out with air. URS/CWC anticipates that some utilities/piping may contain some residual material (e.g. plant water, residual pipe sediment, sewage) from previous activities will take necessary precautions in the handling and disposal of any such materials. All existing underground utilities (e.g. piping conduits, catch basins, manholes, Wilson irrigation ditch) will be plugged/capped and abandoned in place along their entirety utilizing flow fill or other approved material. The flow fill will be introduced using pressure not to exceed 100 psi. The grouting will continue until a steady flow of grout exits the pipe outlet. The outlet will be sealed then the inlet will be grouted under pressure using a pressure between 50 and 100 psi.

3.2.7 Capping of Demolished Areas

The areas where above grade demolition activities will be completed will be sealed in a manner that will mitigate the infiltration of water below the footprint area through existing or created cracks and crevices. These areas will either be covered with a cover system described in the Cover System Design (Hydrometrics, 2008), or covered with an interim caps described in Section 3.2.6.1. Most of the areas scheduled for cleaning and demolition in 2008 are addressed in the Cover System Design plan. However, a portion of the 2008 work including a section of the blast furnace flue and crusher mill building area is scheduled for a temporary capping in 2008. Permanent cover and temporary capping areas scheduled for 2008 are shown in Figure 3-3.

3.2.7.1 Interim Cap Techniques, Procedures and Materials

The blast furnace flue and crusher mill building areas where above grade demolition activities will be completed will be covered in 2008 as delineated on Figures 3-3 and 3-4 with 10-oz geotextile and a geomembrane cap of 24-mil RPE liner.

Upon completion of the demolition operations and area clean-up, URS/CWC will remove all debris and items from the slab that could possibly penetrate the geotextile and geomembrane. URS/CWC will utilize the existing on-site fumed slag as fill material over the remaining demolition slabs/areas. This fumed slag will be placed and rough graded to create the positive drainage required per the Construction Document Drawings. The fumed slag has

been used as a grading material at the plant site in the past and possesses good physical characteristics for fill or sub-foundation uses (granular material and compacts wells). Although fumed slag contains elevated total metal concentrations, the metals are bound in a silicate-iron matrix with characteristics of low metal leachability. The potential for metal migration from the fumed slag is low. In response to EPA's July 6, 2006 comments, Asarco provided the rationale for using fumed slag for backfilling purposes, including study results derived from the RCRA Consent Decree investigations. The slag-related investigative results contained in the Current Condition Release Assessment (CC/RA, January 1999) and qualitative analyses of fumed slag (May 2001) are attached as Appendix D. In April 2005, Montana Department of Environmental Quality representatives collected fumed slag samples from the East Helena Plant to assess the potential environmental impacts from its use as an iron substitute within the cement manufacturing industry. A copy of the April 2005 fumed slag sampling event results is attached as Appendix D. A July 2006 Department Environmental Impact Statement (EIS) contains additional slag related information.

The geotextile and geomembrane will be laid, seamed, and secured as detailed. Additionally, sandbags will be placed intermittently within the center liner area to prevent the liner from being picked up by wind uplift or other forces. This will be done in sufficient quantity to ensure the liner stays in place. As an added preventative measure, URS/CWC will utilize sandbags made of UV Resistant 9-mil PE, which will provide superior UV resistance (compared to standard plastic woven sandbags) to prevent breakdown by sunlight.

The interim caps will be constructed to cover newly exposed footprints in the demolition areas. Depending on when the work is initiated, work sequencing and/or weather conditions, the interim cap installation may be conducted before final removal of flue dust and impacted sub-surface soils in exposed areas (see 2.3.2 above). Scheduling is discussed further in Section 4.0.

The interim cap details and specifications are shown on Figure 3-4. In general, from the top down, the interim cap will consist of the following:

- Sand bags to hold down the interim cover during windy periods
- A 24-mil reinforced polyethylene (RPE) with the PRE seams overlapped 3 inches and sewn
- A minimum 10 ounce non-woven geotextile
- A prepared sub-grade consisting of fumed slag fill for grading purposes and
- Existing soils, concrete slabs and/or concrete foundations.

3.2.7.2 Maintenance of Interim Cap

Site Inspection

Periodic inspections of the interim cap will be conducted to ensure that the interim cap systems are performing adequately and to identify problems and provide proper maintenance of interim cap systems. The inspection program will involve three types of inspections: (1) informal inspections, (2) periodic technical inspections, and (3) special inspections after extreme events.

The informal inspection is actually a continuing effort by on-site personnel, performed in the course of their normal duties. Periodic technical inspections and inspections after extreme events will be performed by onsite Asarco staff (or other technical representatives) familiar with the design and construction of the cover systems. The periodic technical inspection will be performed monthly to document the condition of the cap components. Special inspections are very similar to periodic technical inspections but are performed only after an extreme event such as a rare rainstorm, tornado, or earthquake.

The inspection of the cover systems will typically involve walking the entire site in a systematic fashion that ensures a comprehensive review. If any problem or deficiency is found, the inspector will record the location on a field sketch. A complete description of the affected area, including all pertinent data (i.e., size of the area and other descriptive remarks such as exposed synthetic materials) will be recorded on the appropriate reporting forms. An accurate and

detailed description of observed conditions will enable a meaningful comparison of conditions observed at different times.

Photographs may be helpful in documenting problems. Provisions will be made to keep a photographic log of problems, repairs, and general site conditions. This log will provide valuable information when evaluating the performance of the cover system and when planning repair strategies.

It is important to have a record of site conditions at various stages after capping. Good documentation will provide valuable information to help maintenance and repair planning. Inspection checklists to assist in the inspection and documentation procedures will be developed and modified as needed throughout the interim capping period. The checklist will (at a minimum) contain items to evaluate such as membrane condition, sand bag condition, liner seams, liner/concrete attachments and site drainage. A copy of an example inspection form is attached in Appendix E.

Site Security

The interim cap will be contained within the fenced Asarco facility and will be kept secured so that people or animals do not disturb the cap. Site access for ongoing plant or demolition operations will be limited through the use of barricades, barrier tape, or temporary fencing. Plant personnel will advise contractors conducting site activities of access limits within or near capped areas.

Site Maintenance

As shown in Table 3-1, there are four different types of maintenance tasks listed by priority rather than by frequency. Table 3-1 is provided as a guide to prioritize the different types of maintenance activities in proper perspective. The different types of maintenance are also discussed in the following subsections.

1. Emergency maintenance - Emergencies are situations arising unexpectedly that require urgent attention. Often, immediate response must be provided to avert potential serious

damage. Provisions for emergency repair/damage control activities must therefore be in-place prior to the occurrence. Toward this end, an Emergency Contacts list will be prepared and kept current, and include local emergency response organizations, assigned maintenance personnel, and agency and owner representatives. Table 3-2 provides a partial list of emergency contacts.

2. Preventative maintenance - Preventative maintenance will be performed to extend the life of equipment and structures. With the exception of routine surveillance and inspections, preventative maintenance tasks should be scheduled in accordance with the recommendations of the material and equipment manufacturers. Scheduled inspection and maintenance of all site facilities will help ensure that potential problems are discovered and corrected before they become serious, as well as providing for the performance of periodically required upkeep. During routine inspections, the Asarco personnel should be alert for any abnormal conditions, which could indicate potential problems.
3. Corrective maintenance - Corrective maintenance consists of repair and other non-routine maintenance. Asarco personnel must always be ready to handle these tasks as the need arises. Corrective maintenance procedures should follow the equipment or material manufacturer's recommendations. In planning for the corrective maintenance, arrange for the assistance of an engineer or manufacturer's representative, if necessary.
4. Housekeeping - Maintaining well-kept facilities indicates pride on the part of the Asarco personnel, and provides for good and efficient operations. Well-kept property cultivates good neighbor relations with adjacent property owners. Housekeeping tasks may include collecting/disposing of litter or debris and maintaining access barriers.

3.2.8 Water Pollution Prevention Plan

Storm water during demolition will be managed in accordance with the Storm Water Pollution Prevention Plan (SWPPP) outlined in the 2007 Cleaning and Demolition Work Plan (URS, 2007) and described as follows:

URS understands and appreciates the importance of the SWPPP due to the present concerns and conditions of the ASARCO facility. URS will utilize Best Management

Practices (BMPs) for various construction activities. From the existing SWPPP, applicable information, such as management practices for the hazardous material storage areas, will be incorporated into URS' Best Management Practices. Other material handling practices related specifically to the decontamination and demolition activities will be addressed. Management practices for cross-contamination control will be addressed, such as avoiding spills from construction vehicles during hauling, loading, servicing, and fueling and controlling contaminated soil erosion. Changes to the storm drainage system due to demolition will be addressed as the structures are demolished and the site conditions change.

Standard erosion control measures will also be utilized, including controlling dust, providing straw bales around storm drain inlets, placing sand-bags at critical perimeter locations, and avoiding off-site tracking of debris from vehicles. Provisions to avoid ponding and maintain excavations free of storm water runoff will be addressed. Typically, this will involve filling these locations prior to storms. Measures for erosion control will be added as the project progresses.

Inspection of the erosion control measures will be made prior to, during, and after storms to evaluate the adequacy of these measures and to manage corrections as necessary. Documentation of the inspection and correction activities will be maintained, as required. Generally, the inspection and documentation will be done by the Project Manager / Engineer. Copies of the documentation will be forwarded to ASARCO for review and records.

3.2.9 Dust Control Plan

Dust control will be performed in accordance with the dust control plan outlined in the 2007 Cleaning and Demolition Work Plan (URS, 2007) and is described as follows:

The general requirements of this plan are to provide adequate resources to control dust and to detail the means and methods that will be utilized to implement dust control measures during the cleaning and demolition in order to support scheduled activities/operations within the ASARCO facility. URS/CWC's dust control measures

are designed to control the emission of visible fugitive nuisance dust. These controls will be accomplished through the use of administrative, engineering, and physical controls that will include, but not be limited to the following:

- Moistening surfaces with water
- Application of dust suppressants or encapsulates, where applicable
- Minimizing soil, road, and surface disturbances
- Minimize dusting exposure periods and wind erosion before dust-abatement measures are applied
- Curtailing of work activities during high wind conditions (over 15 MPH average hourly rate)
- Controlling vehicle/equipment speeds (10 MPH maximum)
- Restricting traffic to designated roads/corridors and
- Equipment Selection.

URS/CWC considers the mitigation of airborne dust generation to be a priority. Throughout the project, URS/CWC will take all necessary steps to effectively control dust in the working area during demolition operations. As previously mentioned, URS/CWC will remove at ground level and at all accessible areas all gross debris accumulation that could be a source of airborne dust. Furthermore, URS/CWC will institute a program of pre-wetting and moistening building interiors and horizontal surfaces where dust has accumulated. This pre-wetting of the structure interiors will limit the ability of remaining dust to become airborne during the demolition process. As the structures are demolished, the dust will be allowed to fall to the ground where it can be gathered, containerized appropriately, and properly managed.

3.2.9.1 Application with Water During Demolition

The use of water will be the main source for dust control. URS/CWC will keep all work areas (including roads, access points) within the facility, wet during work activities. This will be accomplished by using existing 2,000-gallon water trucks. Each water truck will be equipped with spray-bars for wetting haul and access roads; water cannons and necessary

hoses, valves, and fittings will be used to provide spray water for dust control where needed in remote areas where a water truck can not be utilized.

Furthermore, during the life of the project water truck(s) will be available during the actual demolition of the above grade steel and concrete structures. Localized fine water spray pointed at the source of demolition (and therefore dust source) reduces dust particles to become airborne. Additionally, URS will utilize a Dust Boss™ water misting system. The Dust Boss™ is a fully automatic, oscillating ducted fan with a high pressure misting system that creates a high performance dust barrier. Dust Boss™ uses a high pressure misting system to create an ultrafine mist that attracts dust and drives it to the ground. During structure demolition, this equipment will be pre-positioned in an area that will ensure the generated dust barrier is effective. To minimize water run-off, both the water truck and Dust Boss™ water supply will be used only if necessary.

3.2.9.2 Dust Control During Loading and Debris Transportation

During loading, unloading, and material transfer operations, URS/CWC will minimize material drop heights to reduce emission of fugitive dust. During loading of demolition debris, additional spray water will be utilized to control fugitive dust emissions from this operation. After demolition debris is loaded into the truck beds, URS/CWC will then moisten the debris payload down prior to the vehicle leaving the loading areas.

As described above, during debris transportation, URS/CWC will construct a truck moistening station at the exit of the ASARCO site over to the CAMU site. This station will consist of a scaffolding platform on which personnel will mist water on the loaded debris as a final step before it travels outside the property fence line and across the County road. The spray will add a final moisture barrier/binder to the debris for the short distance to the CAMU. Transport vehicles will be limited to a maximum 10 miles per hour while both on-site and during transport. Limiting speeds will prevent dust from become airborne during transport and will prevent the kick-up of dust due to rolling tire action.

At the CAMU dump area, a water truck will be placed to lightly mist debris and knock down any dust during the dumping and spreading phase of the debris in the CAMU. Use of water will be kept at a minimum at all times, however, the elimination of dust will be given top priority.

3.2.9.3 Dust Suppressant

The primary dust control measure to be used will be water. However, the application of an accepted dust suppressant dispersed from the water truck or special equipment as a dust suppressant may be required during periods of time that the application of water alone is inadequate for dust control. Dust suppressant product information and MSDSs will be submitted for approval prior to the usage and/or application.

3.2.9.4 Area Control

URS/CWC will use specific loading areas for each decontamination/demolition removal location to minimize disturbances and control material transfer operations. During the demolition of each structure, URS/CWC will designate a staging and loading area directly adjacent to each structure. Often this area will be within the footprint of the structure being demolished. This staging and loading area, specific to each structure, will be kept constant and will be maintained to control the migration of dust and debris from moving material unnecessarily.

3.2.9.5 Water Source

URS/CWC will utilize the existing ASARCO provided fill station, adjacent to Upper Lake, as the source of non-potable water to be utilized for dust suppression operations.

3.2.9.6 Field Quality Control

URS/CWC Project Staff (i.e., Project Superintendent, Foreman, H&SP) will inspect work areas daily to assess the need for implementation (or additional implementation) of dust control measures.

3.2.9.7 Overall Dust Control Application

URS/CWC will control fugitive dust emissions by using the following overall methods:

- Provide dust suppression (water) before, during, and after demolition of a structure, provided it is safe to do so.
- In cases where structures are to be dropped (stack demolition, elevated structures), URS/CWC will moisten the targeted drop area prior to the demolition of the structure.
- Provide dust control during material sizing and loading operations.
- Control material drop heights during loading, unloading and material transfer operations.
- Minimize and control material handling operations.
- On-site vehicular traffic control and haul road maintenance.

If necessary, URS/CWC will apply other approved methods for control of dust during specific procedures.

4.0 SCHEDULE

A preliminary schedule for cleaning and demolition, and soil sampling project is in Figure 4-1. The schedule is preliminary and is dependent on the sequencing of several other cleaning and demolition projects that are addressed in the Cleaning and Demolition Plan (URS, 2007). Key events include:

- Construction of the CAMU
- Pre-demolition Cleaning
- Demolition of structures
- Stack demolition
- Flue demolition
- Flue dust removal and associated impacted soils from exposed soil areas and
- Interim Cap.

5.0 REFERENCES

- ASARCO LLC, 2007a. Asarco East Helena Smelter, 2007 Interim Measures Work Plan Addendum, Blast Furnace Flue and Monier Flue, Cleaning, Demolition and Soil Sampling Work Plan, May 5, 2007.
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- URS, 2007. Work Plan, 2007 Cleaning & Demolition Project and CAMU Phase 2 Cell Project, Asarco East Helena Plant, East Helena, Montana, May 2007.

TABLES

TABLE 2-1. SITE WIDE SOIL SUMMARY STATISTICS FOR SURFACE SOILS

0"-4" Depth Interval

Parameter	Detection Frequency	Arithmetic Mean	Median	Minimum	Maximum	Location of Maximum	Standard Deviation	Geo. Mean Background	Enrichment Factor	Geometric Mean
ARSENIC (AS) TOT	173/183	2159	1028	0.01	35500	SS-12	3753	16.5	26	432
COPPER (CU) TOT	175/183	5522	3225	0.01	35750	RC-SA02D-1, 4/24/2001	6917	16.3	69	1127
CADMIUM (CD) TOT	167/183	1225	354	0.05	23400	SS-18	2830	0.24	816	196
LEAD (PB) TOT	177/183	16615	10875	0.01	73866	RC-SS17, 4/18/01	17967	11.6	296	3439
ZINC (ZN) TOT	179/183	13672	7916	0.05	88519	RC-SS25, 4/25/01	17388	46.9	63	2940

4"-12" Depth Interval

Parameter	Detection Frequency	Arithmetic Mean	Median	Minimum	Maximum	Location of Maximum	Standard Deviation	Geo. Mean Background	Enrichment Factor	Geometric Mean
ARSENIC (AS) TOT	144/155	1133	503	0.10	8753	RC-SS05C-2, 4/6/2001	1518	16.5	17	276
COPPER (CU) TOT	148/155	2624	1319	0.10	16054	RC-SS05C-2, 4/6/2001	3421	16.3	37	604
CADMIUM (CD) TOT	136/155	662	239	0.05	13992	RC-SS06, 4/06/01	1436	0.24	535	128
LEAD (PB) TOT	152/155	12717	7125	0.05	77220	RC-SS07D, 4/09/01	16583	11.6	210	2431
ZINC (ZN) TOT	153/155	9791	6263	0.05	57288	RC-SA06, 4/24/01	11284	46.9	53	2492

1'-2' Depth Interval

Parameter	Detection Frequency	Arithmetic Mean	Median	Minimum	Maximum	Location of Maximum	Standard Deviation	Geo. Mean Background	Enrichment Factor	Geometric Mean
ARSENIC (AS) TOT	148/154	825	338	0.03	9256	UOS-SS11-3, 10/3/2001	1405	16.5	13	209
COPPER (CU) TOT	148/154	1999	790	0.01	64908	UPS-SS01-3, 3/20/2001	5521	16.3	26	416
CADMIUM (CD) TOT	121/154	415	111	0.02	10110	RC-SS06, 4/06/01	980	0.24	303	73
LEAD (PB) TOT	152/154	8147	3219	0.03	64307	UPS-SS01, 3/20/01	11119	11.6	136	1574
ZINC (ZN) TOT	153/154	6552	4166	0.05	35772	RC-SS20, 4/18/01	7035	46.9	38	1795

2'-3' Depth Interval

Parameter	Detection Frequency	Arithmetic Mean	Median	Minimum	Maximum	Location of Maximum	Standard Deviation	Geo. Mean Background	Enrichment Factor	Geometric Mean
ARSENIC (AS) TOT	116/128	518	130	0.012	4455	RC-SS06-4, 4/6/2001	906	16.5	6	97
COPPER (CU) TOT	122/128	1130	396	0.004	6741	RC-SS08-4, 4/9/2001	1579	16.3	14	229
CADMIUM (CD) TOT	92/128	397	44	0.003	13588	RC-SS06, 4/06/01	1316	0.24	174	42
LEAD (PB) TOT	123/128	5153	1193	0.003	37460	LOS-SS06, 4/06/01	7888	11.6	60	696
ZINC (ZN) TOT	127/128	6070	1731	0.032	56395	LOS-SS05, 4/05/01	9052	46.9	21	979

3'-5' Depth Interval

Parameter	Detection Frequency	Arithmetic Mean	Median	Minimum	Maximum	Location of Maximum	Standard Deviation	Geo. Mean Background	Enrichment Factor	Geometric Mean
ARSENIC (AS) TOT	36/39	300	165	10.00	1608	UOS-SS05-5, 4/17/2001	407	16.5	7	115
COPPER (CU) TOT	39/39	671	286	21.00	5763	UOS-SS07-5, 4/17/2001	1051	16.3	15	239
CADMIUM (CD) TOT	28/39	202	51	5.00	1430	RC-SS07C, 4/9/01	349	0.24	203	49
LEAD (PB) TOT	39/39	3547	1885	27.00	15928	UOS-SS05, 4/17/01	4456	11.6	93	1078
ZINC (ZN) TOT	39/39	3159	1000	45.00	12826	LOS-SS10, 4/6/01	3904	46.9	21	980

5'-8' Depth Interval

Parameter	Detection Frequency	Arithmetic Mean	Median	Minimum	Maximum	Location of Maximum	Standard Deviation	Geo. Mean Background	Enrichment Factor	Geometric Mean
ARSENIC (AS) TOT	30/31	304	49	11.00	2553	RC-SA08A-5, 4/25/2001	592	16.5	4	73
COPPER (CU) TOT	31/31	715	116	17.00	6181	RC-SS27-6, 4/9/2001	1339	16.3	11	185
CADMIUM (CD) TOT	24/31	131	32	5.00	741	RC-SS27, 4/9/01	188	0.24	170	41
LEAD (PB) TOT	31/31	5463	1593	23.00	26889	RC-SS27, 4/9/01	7733	11.6	109	1267
ZINC (ZN) TOT	31/31	4987	1354	46.00	39575	RC-SA06, 4/24/01	8190	46.9	26	1219

8'-11' Depth Interval

Parameter	Detection Frequency	Arithmetic Mean	Median	Minimum	Maximum	Location of Maximum	Standard Deviation	Geo. Mean Background	Enrichment Factor	Geometric Mean
ARSENIC (AS) TOT	4/4	408	181	16.00	1255	RC-SA08B-8, 4/25/2001	570	16.5	10	160
COPPER (CU) TOT	4/4	779	669	44.00	1734	RC-SA08B-8, 4/25/2001	704	16.3	26	429
CADMIUM (CD) TOT	2/4	68	8	5.00	251	RC-SA08B, 4/25/01	122	0.24	68	16
LEAD (PB) TOT	4/4	1126	182	176.00	3962	RC-SA08B, 4/25/01	1891	11.6	34	390
ZINC (ZN) TOT	4/4	2531	360	138.00	9265	RC-SA08B, 4/25/01	4492	46.9	13	618

TOT = Total

1/2 the detection limit used for non-detected values.

All analytical values are in mg/Kg

Source: Table 2-3-1, Phase I RFI Report, ACI, 2003.

TABLE 2-2. SITE WIDE SOIL SUMMARY STATISTICS FOR UNPAVED (EXPOSED) ON-PLANT SITE AREAS

0"-4" Depth Interval

Parameter	Detection Frequency	Arithmetic Mean	Median	Minimum	Maximum	Location of Maximum	Standard Deviation	Geomean Background	Enrichment Factor	Geometric Mean
ARSENIC (AS) TOT	19/19	2174	460	0.10	17075	UPS-SS1, 3/20/01 UPS-SS4, 3/16/01 SS-31	3970	16.5	19	315
COPPER (CU) TOT	19/19	5119	1100	0.10	35350		8806	16.3	44	709
CADMIUM (CD) TOT	18/19	662	433	0.05	3069		954	0.24	1121	269
LEAD (PB) TOT	18/19	9024	8813	0.05	39046		10263	11.6	281	3256
ZINC (ZN) TOT	18/19	12039	6421	0.05	84650		21706	46.9	71	3318

4"-12" Depth Interval

Parameter	Detection Frequency	Arithmetic Mean	Median	Minimum	Maximum	Location of Maximum	Standard Deviation	Geo. Mean Background	Enrichment Factor	Geometric Mean
ARSENIC (AS) TOT	16/18	678	349	0.10	2148	UPS-SS1, 3/20/01 UPS-SS6, 3/20/01 UPS-SS14, 3/20/01	723	16.5	10	160
COPPER (CU) TOT	18/18	1970	754	0.10	9395		2673	16.3	20	326
CADMIUM (CD) TOT	16/18	224	88	0.05	901		267	0.24	263	63
LEAD (PB) TOT	17/18	7345	4625	0.05	24682		7703	11.6	114	1322
ZINC (ZN) TOT	17/18	9619	7874	0.05	41322		11105	46.9	33	1548

1'-2' Depth Interval

Parameter	Detection Frequency	Arithmetic Mean	Median	Minimum	Maximum	Location of Maximum	Standard Deviation	Geo. Mean Background	Enrichment Factor	Geometric Mean
ARSENIC (AS) TOT	14/15	610	164	0.10	3100	UPS-SS13, 3/20/01 UPS-SS1, 3/20/01 UPS-SS12, 3/16/01	941	16.5	7	119
COPPER (CU) TOT	15/15	5385	206	0.10	64908		16574	16.3	17	274
CADMIUM (CD) TOT	11/15	92	38	0.05	312		102	0.24	117	28
LEAD (PB) TOT	14/15	8304	968	0.05	64307		17002	11.6	73	846
ZINC (ZN) TOT	14/15	4921	1647	0.05	22123		6868	46.9	15	722

2'-4' Depth Interval

Parameter	Detection Frequency	Arithmetic Mean	Median	Minimum	Maximum	Location of Maximum	Standard Deviation	Geo. Mean Background	Enrichment Factor	Geometric Mean
ARSENIC (AS) TOT	12/13	165	130	10	465	UPS-SS1, 3/20/01 UPS-SS13, 3/20/01 UPS-SS13, 3/20/01	162	16.5	5	84
COPPER (CU) TOT	13/13	778	147	14	3522		1095	16.3	13	218
CADMIUM (CD) TOT	8/13	35	17	5	107		35	0.24	80	19
LEAD (PB) TOT	13/13	2080	932	23	9636		2884	11.6	52	598
ZINC (ZN) TOT	13/13	7881	532	15	41455		13187	46.9	18	852

TOT = Total

1/2 the detection limit used for non-detected values.

All analytical values are in mg/Kg

Source: Table 2-3-3, Phase I RFI Report, ACI, 2003.

Shading indicates numeric criteria used to determine limit of sample excavation. See Table 2-3

Sample Location	Purpose	Sample Types and Depth Intervals ⁽¹⁾	Number of Sampling Events	Sampling Standard Operating Procedures	Analytical Parameters	Methods	Project Detection Limit Goal	Excavation Concentration Removal Limits (mg/kg or ppm)	Soil Excavation Removal and Sampling Protocols in Unpaved Bare Soil Areas Within the Flue Demolition Foot Print Area
Speiss-Dross and Thaw House Area (Area 1) (15 Sites)	Remove dust and impacted soils in exposed or unpaved areas within the structure demolition foot print. Determine depth of excavation.	Sample from Excavator Bucket. Sample intervals: 0-4" 4'-12" 1'-2' 2'-4' 4'-6' 6'-8' 8'-10' 10'12' 12-15	1	HF-SOP-2 HF-SOP-4 HF-SOP-5 HF-SOP-7 HF-SOP-29 HF-SOP-31 HF-SOP-58 HS-SOP-6 HS-SOP-13 HS-SOP-57	Indicator Parameters (5) (All Depth Increments)	XRF	20 ppm	165	Obvious flue dust or flue dust soils is removed based on visual observation (fine texture, dark gray color). Excavation continues until: - The values for As, Cd, Cu, Pb, Zn are below removal limits - The practical limit of excavation equipment is reached (typically 12 to 15 feet) - The water table is encountered. The final sample increment is retained and analyzed for by wet chemistry for Indicator Parameters, Supplemental Parameters and SPLP.
As					ICP/ICP-MS EPA SW6010/6020	5 ppm			
Cd					XRF	25 ppm	778		
Cu					ICP/ICP-MS EPA SW6010/6020	1 ppm	35		
Pb					XRF	25 ppm	2080		
Zn					ICP/ICP-MS EPA SW6010/6020	5 ppm	7881		
Se					ICP/ICP-MS EPA SW6010/6020	25 ppm	Source:		
Supplemental Parameters (13) (Initial and Final Depth Increments)					XRF	5 ppm	Table 2-2, arithmetic mean for the 2 to 4 foot increment.		
Al					ICP/ICP-MS EPA SW6010/6020	5 ppm			
Sb					ICP/ICP-MS EPA SW6010/6020	5 ppm			
Ba					ICP/ICP-MS EPA SW6010/6020	5 ppm			
Be					ICP/ICP-MS EPA SW6010/6020	5 ppm			
Cr					ICP/ICP-MS EPA SW6010/6020	5 ppm			
Co					ICP/ICP-MS EPA SW6010/6020	5 ppm			
Hg					EPA SW7471	0.05 ppm			
Fe					ICP/ICP-MS EPA SW6010/6020	5 ppm			
Mn					ICP/ICP-MS EPA SW6010/6020	5 ppm			
Ni					ICP/ICP-MS EPA SW6010/6020	5 ppm			
Ag					ICP/ICP-MS EPA SW6010/6020	5 ppm			
Tl					ICP/ICP-MS EPA SW6010/6020	5 ppm			
V	ICP/ICP-MS EPA SW6010/6020	5 ppm							
Former Zinc Shop and Meeting Room Area (Area 7) (4 sites)	Document metal concentrations in test leachate from the SPLP testing procedure	Final increment sampled from excavator bucket and sampled for metals and analyzed by XRF	1		As Cd Cu Pb Zn Se	SPLP (EPA 1312) SPLP (EPA 1312) SPLP (EPA 1312) SPLP (EPA 1312) SPLP (EPA 1312) SPLP (EPA 1312)	0.1 mg/l 0.1 mg/l 0.1 mg/l 0.1 mg/l 0.1 mg/l 0.1 mg/l		

Shading shows numeric criteria used to determine limit of sample excavation (see Table 2-2).

TABLE 2-4. SUMMARY OF SOIL SAMPLE DATA ADJACENT TO THE FORMER SPEISS-DROSS AREA AND ADJACENT TO THE THAW HOUSE

Sample Area Number	1												
Parameter	Surface Soil Sample Site Number						Monitoring Well Soil Sample Site Number						
	UPS-SS13	UPS-SS06	UPS-SS08	LOS-SS14	LOS-SS16A	LOS-SS16B	DH-13	DH-26	DH-27	DH-30	DH-35	DH-36	DH-66
0'-4" Depth Interval													
ARSENIC (AS) TOT	1748	45	203	1007	276	261	3163				2346		
COPPER (CU) TOT	8221	179	787	1522	797	812	17125				8679		
CADMIUM (CD) TOT	843	92	80	277	208	216	1610				538		
LEAD (PB) TOT	14989	630	2624	7975	3331	3361	24200				12879		
ZINC (ZN) TOT	8045	350	1347	4387	2668	3002	14450				8672		
4'-12" Depth Interval													
ARSENIC (AS) TOT	1924	1879	83	1353	21		389						
COPPER (CU) TOT	7438	3892	259	1888	40		930						
CADMIUM (CD) TOT	501	701	48	441	<10		84						
LEAD (PB) TOT	14334	24682	1169	15362	114		11290						
ZINC (ZN) TOT	9131	18867	828	6263	96		588						
1'-2' Depth Interval													
ARSENIC (AS) TOT	1894	48	80	1100	17		28			1288		447	
COPPER (CU) TOT	7092	154	148	1213	47		88			4970		873	
CADMIUM (CD) TOT	312	28	33	661	<10		2			234		34	
LEAD (PB) TOT	19676	694	913	12027	127		209			11574		4300	
ZINC (ZN) TOT	13821	605	612	10971	123		66			26012		28454	
2'-4' Depth Interval													
ARSENIC (AS) TOT	415	27	48	210	15	18	65	450	32	6523	1491	23	
COPPER (CU) TOT	1695	133	147	425	38	23	75	350	63	110	6166	54	
CADMIUM (CD) TOT	50	17	28	40	<10	<10	3	60	1	2855	445	<10	
LEAD (PB) TOT	9636	945	722	1760	45	47	273	25500	9	19079	8529	80	
ZINC (ZN) TOT	41455	532	493	1715	74	88	111	520	140	1045	7505	450	
3'-4' Depth Interval													
ARSENIC (AS) TOT		14			12		32						127
COPPER (CU) TOT		43			23		25						535
CADMIUM (CD) TOT		<10			<10		1						97
LEAD (PB) TOT		110			26		63						2569
ZINC (ZN) TOT		103			55		52						1390
4'-6' Depth Interval													
ARSENIC (AS) TOT					15	22	27	275	132	6739	91	27	
COPPER (CU) TOT					22	35	31	14	76	111	207	83	
CADMIUM (CD) TOT					<10	<10	1	2	2	3011	<10	<10	
LEAD (PB) TOT					17	29	86	23	22750	19549	444	43	
ZINC (ZN) TOT					57	69	42	38	105	1082	648	192	
6-8' Depth Interval													
ARSENIC (AS) TOT					11			164	162		222	21	178
COPPER (CU) TOT					18			28	35		138	76	508
CADMIUM (CD) TOT					<10			3	2		<10	<10	103
LEAD (PB) TOT					17			105	7		182	23	3086
ZINC (ZN) TOT					42			100	38		113	70	1911
8-10' Depth Interval													
ARSENIC (AS) TOT								172	74	754	83		
COPPER (CU) TOT								30	77	190	84		
CADMIUM (CD) TOT								1	1	1465	<10		
LEAD (PB) TOT								21	34	127	38		
ZINC (ZN) TOT								43	72	1175	87		
10-12' Depth Interval													
ARSENIC (AS) TOT						81		100		731	72		15
COPPER (CU) TOT						24		48		89	114		45
CADMIUM (CD) TOT						<10		3		1081	<10		<10
LEAD (PB) TOT						25		91		127	56		22

TABLE 2-4. SUMMARY OF SOIL SAMPLE DATA ADJACENT TO THE FORMER SPEISS-DROSS AREA AND ADJACENT TO THE THAW HOUSE

Sample Area Number	1												
ZINC (ZN) TOT						66		100		1281	109		88
Parameter	Surface Soil Sample Site Number						Monitoring Well Soil Sample Site Number						
	UPS-SS-13	UPS-SS06	UPS-SS08	LOS-SS14	LOS-116A	LOS-SS16B	DH-13	DH-26	DH-27	DH-30	DH-35	DH-36	DH-66
15-17' Depth Interval													
ARSENIC (AS) TOT								92		160	90	<10	27
COPPER (CU) TOT								65		76	92	66	49
CADMIUM (CD) TOT								1		1686	<10	<10	<10
LEAD (PB) TOT								23		93	41	21	25
ZINC (ZN) TOT								62		774	63	116	42
20-22' Depth Interval													
ARSENIC (AS) TOT								100		502	128	88	
COPPER (CU) TOT								90		138	66	75	
CADMIUM (CD) TOT								2		610	57	<10	
LEAD (PB) TOT								42		31	42	23	
ZINC (ZN) TOT								81			83	73	
25-25.5' Depth Interval												24-26'	25-27'
ARSENIC (AS) TOT							1434	122	100		221	161	14
COPPER (CU) TOT							200	74	32		70	62	77
CADMIUM (CD) TOT							10	5	11		567	<10	<10
LEAD (PB) TOT							120	440	14		26	18	47
ZINC (ZN) TOT							1013	425	720		77	71	53

TOT = Total

All analytical values are in mg/Kg

Source: Appendices 2 and 7, Phase I RFI Report, ACI, 2003. □

Note: Depth intervals have been normalized for comparison purposes. For example, the 4-6 foot increment in some samples may actually be a 3-5 foot sample increment. The actual sample increments are in the data reports included in Appendix A

Shading = No data available for these depth intervals

TABLE 2-5. EXPOSED SOIL SAMPLE DATA COLLECTED IN THE THAW HOUSE AND MAIN OFFICE BUILDING DEMOLITION FOOTPRINTS

Site/ Sample #	Sample Interval (ft)	Sample Date (m/d/y)	Sample Time (hr/min/sec)	Description Interval (ft)	Analytical Parameters	As (mg/kg)	Cd (mg/kg)	CU (mg/kg)	Pb (mg/kg)	Zn (mg/kg)
TH1	A1	10/01/07	10:45	0-4"	Total Metals	70	300	160	310	4000
	B1	10/01/07	10:45	4-12"	Total Metals	<5	50	9	27	1400
	C1	10/01/07	10:45	1-2'	Total Metals	65	54	68	460	1200
	D1	10/01/07	10:45	2-4'	Total Metals	18	9	14	77	270
	E1	10/01/07	10:45	4-6'	Total Metals	17	4	12	20	120
	F1	10/01/07	10:45	6-8'	Total Metals	6	1	12	<5	37
	G1	10/01/07	10:45	8-10'	Total Metals	<5	1	11	<5	29
	H1	10/01/07	10:45	10-12'	Total Metals	11	2	36	<5	37
	I1	10/01/07	10:45	12-15'	Total Metals	7	2	20	<5	45
	I1	10/01/07	10:45		SPLP	<0.5	<1	<0.5	<0.1	<0.5
TH2	A1	10/01/07	12:00	0-4"	Total Metals	250	170	330	3500	3200
	B1	10/01/07	12:00	4-12"	Total Metals	<5	<1	5	<5	33
	C1	10/01/07	12:00	1-2'	Total Metals	34	8	23	110	220
	D1	10/01/07	12:00	2-4'	Total Metals	13	2	14	74	62
	E1	10/01/07	12:00	4-6'	Total Metals	<5	<1	<5	<5	35
	F1	10/01/07	12:00	6-8'	Total Metals	17	2	12	65	72
	G1	10/01/07	12:00	8-10'	Total Metals	16	2	10	14	47
	H1	10/01/07	12:00	10-12'	Total Metals	10	2	12	33	43
	I1	10/01/07	12:00	12-15'	Total Metals	26	2	21	8	39
	I1	10/01/07	12:00		SPLP	<0.5	<1	<0.5	<0.1	<0.5
TH3	A1	10/01/07	13:05	0-4"	Total Metals	630	620	1900	260000	17000
	B1	10/01/07	13:05	4-12"	Total Metals	77	52	100	1300	1400
	C1	10/01/07	13:05	1-2'	Total Metals	15	3	9	83	78
	D1	10/01/07	13:05	2-4'	Total Metals	9	15	19	410	340
	E1	10/01/07	13:05	4-6'	Total Metals	<5	5	6	56	130
	F1	10/01/07	13:05	6-8'	Total Metals	7	12	20	350	340
	G1	10/01/07	13:05	8-10'	Total Metals	<5	3	10	79	98
	H1	10/01/07	13:05	10-12'	Total Metals	<5	10	14	270	320
	I1	10/01/07	13:05	12-15'	Total Metals	<5	1	9	25	63
	I1	10/01/07	13:05		SPLP	<0.5	<1	<0.5	<0.1	<0.5
TH4	A1	10/01/07	13:50	0-4"	Total Metals	130	380	370	13000	13000
	B1	10/01/07	13:50	4-12"	Total Metals	17	46	73	1500	1800
	C1	10/01/07	13:50	1-2'	Total Metals	<5	12	7	390	340
	D1	10/01/07	13:50	2-4'	Total Metals	<5	<1	<5	180	81
	E1	10/01/07	13:50	4-6'	Total Metals	10	1	11	6	51
	F1	10/01/07	13:50	6-8'	Total Metals	10	1	11	<5	51
	G1	10/01/07	13:50	8-10'	Total Metals	8	1	9	<5	44
	H1	10/01/07	13:50	10-12'	Total Metals	9	2	9	11	60
	I1	10/01/07	13:50	12-15'	Total Metals	<5	<1	8	<5	46
	I1	10/01/07	13:50		SPLP	<0.5	<1	<0.5	<0.1	<0.5
TH5	A1	10/01/07	14:10	0-4"	Total Metals	120	190	220	1800	2300
	B1	10/01/07	14:10	4-12"	Total Metals	32	11	26	340	490
	C1	10/01/07	14:10	1-2'	Total Metals	15	12	<5	<5	72
	D1	10/01/07	14:10	2-4'	Total Metals	11	6	10	26	99
	E1	10/01/07	14:10	4-6'	Total Metals	13	1	11	<5	47
	F1	10/01/07	14:10	6-8'	Total Metals	8	1	7	<5	39
	G1	10/01/07	14:10	8-10'	Total Metals	11	21	12	43	300
	H1	10/01/07	14:10	10-12'	Total Metals	8	1	10	<5	44
	I1	10/01/07	14:10	12-15'	Total Metals	7	2	10	<5	43
	I1	10/01/07	14:10		SPLP	<0.5	<1	<0.5	<0.1	<0.5
MO1	A1	09/26/07	14:30	0-4"	Total Metals	1500	310	5900	18000	6300
	B1	09/26/07	14:30	4-12"	Total Metals	120	28	160	790	390
	C1	09/26/07	14:30	1-2'	Total Metals	57	23	170	350	500
	D1	09/26/07	14:30	2-4'	Total Metals	71	15	200	800	320
	E1	09/26/07	14:30	4-6'	Total Metals	81	29	220	1200	590
	F1	09/26/07	14:30	6-8'	Total Metals	56	19	140	640	330
	G1	09/26/07	14:30	8-10'	Total Metals	22	5	52	140	91
	H1	09/26/07	14:30	10-12'	Total Metals	17	4	48	61	58
	I1	09/26/07	14:30	12-15'	Total Metals	19	3	64	27	61
	I1	09/26/07	14:30		SPLP	ND	ND	ND	ND	ND

TABLE 2-6. SUMMARY OF SOIL SAMPLE DATA ADJACENT TO THE BLAST FURNACE FLUE AND MONIER FLUE

Sample Area Number	2 and 3												
	Surface Soil Sample Site Number								Monitoring Well Soil Sample Site Number				
Parameter	SS-22	LOS-SS2	UPS-SS2	UPS-SS1	SS-4	UOS-SS2	UOS-SS3	UOS-SS5	DH-60	DH-39	DH-45	DH-46	DH-30
0"-4" Depth Interval													
ARSENIC (AS) TOT	3100	79	115	437	5650	3121	8091	39	180				
COPPER (CU) TOT	11300	136	87	690	12175	3346	23599	88	718				
CADMIUM (CD) TOT	2213	19	433	3069	14725	10646	9319	40	643				
LEAD (PB) TOT	21950	749	573	8813	23625	28537	71196	376	2819				
ZINC (ZN) TOT	23625	266	481	4628	44050	19494	34579	137	1699				
4"-12" Depth Interval													
ARSENIC (AS) TOT		77	140	1068		382	6958	2394					
COPPER (CU) TOT		248	39	9395		663	11639	2075					
CADMIUM (CD) TOT		30	79	901		1894	4012	346					
LEAD (PB) TOT		866	193	20116		5230	66080	13621					
ZINC (ZN) TOT		525	164	11777		3177	16607	4298					
1'-2' Depth Interval													
ARSENIC (AS) TOT		142	236	3100		1481	1908	1504		386	2186	611	1288
COPPER (CU) TOT		1609	82	64908		2587	2622	2059		3487	4139	660	4970
CADMIUM (CD) TOT		<10	179	213		1113	1009	455		426	355	148	234
LEAD (PB) TOT		331	619	64307		25628	16145	12560		1801	9224	2734	11574
ZINC (ZN) TOT		8332	394	13830		10028	6833	3830		10803	5629	952	26012
2'-4' Depth Interval													
ARSENIC (AS) TOT		42	101	130		122	1022	931	17	131	1194	595	6523
COPPER (CU) TOT		378	27	437		235	6447	736	37	2007	1062	643	110
CADMIUM (CD) TOT		<10	<10	107		497	1847	497	19	17	118	93	2855
LEAD (PB) TOT		146	26	1483		2238	11327	8720	70	146	3381	1794	19079
ZINC (ZN) TOT		1814	41	912		1000	12249	2944	148	16578	3674	527	1045
4'-6' Depth Interval													
ARSENIC (AS) TOT								1608	70	13	2517	308	6739
COPPER (CU) TOT								1492	314	32	3005	329	111
CADMIUM (CD) TOT								1367	215	<10	243	37	3011
LEAD (PB) TOT								15928	945	33	7468	1235	19549
ZINC (ZN) TOT								7173	483	1134	5287	270	1082
6'-8' Depth Interval													
ARSENIC (AS) TOT								475	38		561	250	
COPPER (CU) TOT								295	119		399	282	
CADMIUM (CD) TOT								148	98		138	<10	
LEAD (PB) TOT								1970	417		1282	1658	
ZINC (ZN) TOT								1121	339		928	391	
8'-10' Depth Interval													
ARSENIC (AS) TOT									<10	14	793	218	754
COPPER (CU) TOT									27	33	281	270	190
CADMIUM (CD) TOT									<10	<10	129	22	1465
LEAD (PB) TOT									39	15	765	1032	127
ZINC (ZN) TOT									40	62	549	375	1175
10'-12' Depth Interval													
ARSENIC (AS) TOT									21	18		470	731
COPPER (CU) TOT									56	29		315	89
CADMIUM (CD) TOT									19	<10		31	1081
LEAD (PB) TOT									145	<10		914	127
ZINC (ZN) TOT									110	56		296	1281

TABLE 2-6. SUMMARY OF SOIL SAMPLE DATA ADJACENT TO THE BLAST FURNACE FLUE AND MONIER FLUE

Sample Area Number	2 and 3													
	Surface Soil Sample Site Number								Monitoring Well Soil Sample Site Number					
Parameter	SS-22	LOS-SS2	UPS-SS2	UPS-SS1	SS-4	UOS-SS2	UOS-SS3	UOS-SS5	DH-60	DH-39	DH-45	DH-46	DH-30	
15-17' Depth Interval														
ARSENIC (AS) TOT									<10	12	472	153	160	
COPPER (CU) TOT									50	38	71	88	76	
CADMIUM (CD) TOT									<10	<10	816	<10	1686	
LEAD (PB) TOT									35	24	186	47	93	
ZINC (ZN) TOT									38	57	2790	123	774	
20-22' Depth Interval														
ARSENIC (AS) TOT									<10	13			502	
COPPER (CU) TOT									30	66			138	
CADMIUM (CD) TOT									<10	<10			610	
LEAD (PB) TOT									56	25			31	
ZINC (ZN) TOT									85	53			1675	
25-27' Depth Interval														
ARSENIC (AS) TOT									<10					
COPPER (CU) TOT									18					
CADMIUM (CD) TOT									<10					
LEAD (PB) TOT									51					
ZINC (ZN) TOT									81					
30-32' Depth Interval														
ARSENIC (AS) TOT									<10					
COPPER (CU) TOT									31					
CADMIUM (CD) TOT									<10					
LEAD (PB) TOT									58					
ZINC (ZN) TOT									83					
35-37' Depth Interval														
ARSENIC (AS) TOT									13					
COPPER (CU) TOT									27					
CADMIUM (CD) TOT									<10					
LEAD (PB) TOT									62					
ZINC (ZN) TOT									120					

TOT = Total

All analytical values are in mg/Kg

Source: Appendices 2 and 7, Phase I RFI Report, ACI, 2003. □

Note: Depth intervals have been normalized for comparison purposes. For example, the 4-6 foot increment in some samples may actually be a 3-5 foot sample increment. The actual sample increments are in the data reports included in Appendix A

Shading = No data available for these depth intervals

TABLE 2-7. SUMMARY OF SOIL SAMPLE DATA IN THE ACID PLANT CONTACT AREA (SAMPLE AREA 4)

Sample Area Number	4				
Parameter	Surface Soil Sample Site Number	Monitoring Well Soil Sample Site Number			
	UPS-SS3	DH-40	DH-41	DH-44	APSD-13
0"-4" Depth Interval					
ARSENIC (AS) TOT	33		152	52	7433
COPPER (CU) TOT	94		241	211	
CADMIUM (CD) TOT	64		138	58	111
LEAD (PB) TOT	578		1293	868	256
ZINC (ZN) TOT	181		1014	233	251
4"-12" Depth Interval					
ARSENIC (AS) TOT	16				
COPPER (CU) TOT	43				
CADMIUM (CD) TOT	24				
LEAD (PB) TOT	261				
ZINC (ZN) TOT	81				
1'-2' Depth Interval					
ARSENIC (AS) TOT	146	1683		1354	
COPPER (CU) TOT	414	2977		1936	
CADMIUM (CD) TOT	168	486		300	
LEAD (PB) TOT	2823	14152		11659	
ZINC (ZN) TOT	815	5849		4076	
2'-4' Depth Interval					
ARSENIC (AS) TOT	391	47	374		7443
COPPER (CU) TOT	1509	254	453		
CADMIUM (CD) TOT	71	16	165		107
LEAD (PB) TOT	4614	475	3103		149
ZINC (ZN) TOT	20337	1034	2226		221
4'-6' Depth Interval					
ARSENIC (AS) TOT	57	14	2088	19	7551
COPPER (CU) TOT	125	51	1420	31	
CADMIUM (CD) TOT	19	<10	270	<10	130
LEAD (PB) TOT	753	72	5074	34	197
ZINC (ZN) TOT	373	204	2365	52	227
6'-8' Depth Interval					
ARSENIC (AS) TOT		23	895	18	5952
COPPER (CU) TOT		41	127	37	
CADMIUM (CD) TOT		<10	56	<10	127
LEAD (PB) TOT		94	1809	95	90
ZINC (ZN) TOT		91	352	64	190
8'-10' Depth Interval					
ARSENIC (AS) TOT		14	736	15	5167
COPPER (CU) TOT		54	40	42	
CADMIUM (CD) TOT		<10	37	10	102
LEAD (PB) TOT		32	3728	60	81
ZINC (ZN) TOT		52	196	80	210
10'-12' Depth Interval					
ARSENIC (AS) TOT			2223	38	5757
COPPER (CU) TOT			57	51	
CADMIUM (CD) TOT			10	<10	81
LEAD (PB) TOT			76	94	77
ZINC (ZN) TOT			80	122	211
12'-14' Depth Interval					
ARSENIC (AS) TOT					7194
COPPER (CU) TOT					
CADMIUM (CD) TOT					113
LEAD (PB) TOT					197
ZINC (ZN) TOT					271
14'-16' Depth Interval					
ARSENIC (AS) TOT		977	1553	33	2724
COPPER (CU) TOT		84	53	101	
CADMIUM (CD) TOT		80	<10	<10	101
LEAD (PB) TOT		67	57	103	295
ZINC (ZN) TOT		175	62	103	334

TABLE 2-7. SUMMARY OF SOIL SAMPLE DATA IN THE ACID PLANT CONTACT AREA (SAMPLE AREA 4)

Sample Area Number	4				
Parameter	Surface Soil Sample Site Number	Monitoring Well Soil Sample Site Number			
	UPS-SS3	DH-40	DH-41	DH-44	APSD-13
16-18' Depth Interval					
ARSENIC (AS) TOT					2324
COPPER (CU) TOT					
CADMIUM (CD) TOT					172
LEAD (PB) TOT					298
ZINC (ZN) TOT					419
18-19' Depth Interval					
ARSENIC (AS) TOT					1233
COPPER (CU) TOT					
CADMIUM (CD) TOT					165
LEAD (PB) TOT					8053
ZINC (ZN) TOT					804
20-22' Depth Interval					
ARSENIC (AS) TOT		98	846	250	1760
COPPER (CU) TOT		62	79	81	
CADMIUM (CD) TOT		21	16	82	176
LEAD (PB) TOT		27	33	84	47
ZINC (ZN) TOT		118	146	426	540
25-27' Depth Interval					
ARSENIC (AS) TOT		124		119	
COPPER (CU) TOT		75		82	
CADMIUM (CD) TOT		<10		243	
LEAD (PB) TOT		56		81	
ZINC (ZN) TOT		121		870	
30-32' Depth Interval					
ARSENIC (AS) TOT				21	
COPPER (CU) TOT				33	
CADMIUM (CD) TOT				<10	
LEAD (PB) TOT				88	
ZINC (ZN) TOT				154	

TOT = Total

All analytical values are in mg/Kg

TOT = Total

All analytical values are in mg/Kg

Source: Appendices 2 and 7, Phase I RFI Report, ACI, 2003.

Note:

Depth intervals have been normalized for comparison purposes. For example, the 4-6 foot increment in some samples may actually be a 3-5 foot sample increment. The actual sample increments are in the data reports included in Appendix A

Shading = No data available for these depth intervals

TABLE 2-8. SUMMARY OF SOIL SAMPLE DATA IN THE DIRECT SMELT BUILDING AREA AND SHOP AREA (SAMPLE AREA 6)

Sample Area Number	6			
0"-4" Depth Interval	Surface Soil Sample Site Number		Monitoring Well Soil Sample Site Number	
Parameter	SS-29	UPS-SS4	DH-47	DH-59
ARSENIC (AS) TOT	9525	2297		4567
COPPER (CU) TOT	23700	6011		12726
CADMIUM (CD) TOT	2575	603		400
LEAD (PB) TOT	20300	39046		104528
ZINC (ZN) TOT	48550	11096		16516
4"-12" Depth Interval				
ARSENIC (AS) TOT		1027		
COPPER (CU) TOT		2065		
CADMIUM (CD) TOT		370		
LEAD (PB) TOT		15672		
ZINC (ZN) TOT		6616		
1'-2' Depth Interval				
ARSENIC (AS) TOT		1979	1294	
COPPER (CU) TOT		1721	1090	
CADMIUM (CD) TOT		230	298	
LEAD (PB) TOT		22200	5153	
ZINC (ZN) TOT		6864	1597	
2'-4' Depth Interval				
ARSENIC (AS) TOT			4456	1476
COPPER (CU) TOT			1951	8368
CADMIUM (CD) TOT			222	423
LEAD (PB) TOT			10372	65288
ZINC (ZN) TOT			15060	15109
4'-6' Depth Interval				
ARSENIC (AS) TOT			110	28
COPPER (CU) TOT			58	588
CADMIUM (CD) TOT			<10	37
LEAD (PB) TOT			201	222
ZINC (ZN) TOT			292	401
6-8' Depth Interval				
ARSENIC (AS) TOT			202	
COPPER (CU) TOT			78	
CADMIUM (CD) TOT			<10	
LEAD (PB) TOT			463	
ZINC (ZN) TOT			763	
8-10' Depth Interval				
ARSENIC (AS) TOT				47
COPPER (CU) TOT				575
CADMIUM (CD) TOT				64
LEAD (PB) TOT				309
ZINC (ZN) TOT				624
10-12' Depth Interval				
ARSENIC (AS) TOT				1322
COPPER (CU) TOT				197
CADMIUM (CD) TOT				47
LEAD (PB) TOT				172
ZINC (ZN) TOT				387
15-17' Depth Interval				
ARSENIC (AS) TOT			306	13
COPPER (CU) TOT			426	34
CADMIUM (CD) TOT			<10	10
LEAD (PB) TOT			3829	93
ZINC (ZN) TOT			13667	99
20-22' Depth Interval				
ARSENIC (AS) TOT				224
COPPER (CU) TOT				76
CADMIUM (CD) TOT				324
LEAD (PB) TOT				148
ZINC (ZN) TOT				172
25-27' Depth Interval				
ARSENIC (AS) TOT				169
COPPER (CU) TOT				67
CADMIUM (CD) TOT				60
LEAD (PB) TOT				262
ZINC (ZN) TOT				159

TOT = Total

All analytical values are in mg/Kg

Source: Appendices 2 and 7, Phase I RFI Report, ACI, 2003. □

Note:

Depth intervals have been normalized for comparison purposes. For example, the 4-6 foot increment in some samples may actually be a 3-5 foot sample increment. The actual

sample increments are in the data reports included in Appendix A

Shading = No data available for these depth intervals

**TABLE 2-9. SUMMARY OF SOIL SAMPLE DATA - CRUSHING AND SAMPLE MILL AREA
(SAMPLE AREA 5)**

Sample Area Number	5				
Parameter	Surface Soil Sample Site Number			Monitoring Well Soil Sample Site Number	
	SS-20	UPS-SS4	UPS-SS5	DH-22	DH-43
0"-4" Depth Interval					
ARSENIC (AS) TOT	5450	2297	518		
COPPER (CU) TOT	18625	6011	1100		
CADMIUM (CD) TOT	1733	603	320		
LEAD (PB) TOT	2850	39046	8187		
ZINC (ZN) TOT	26275	11096	2637		
4"-12" Depth Interval					
ARSENIC (AS) TOT		1027	275	125	44
COPPER (CU) TOT		2065	1052	900	201
CADMIUM (CD) TOT		370	343	425	10
LEAD (PB) TOT		15672	4482	8500	330
ZINC (ZN) TOT		6616	1553	2400	148
1'-2' Depth Interval					
ARSENIC (AS) TOT		1979	1329		
COPPER (CU) TOT		1721	712		
CADMIUM (CD) TOT		230	96		
LEAD (PB) TOT		22200	7646		
ZINC (ZN) TOT		6864	2522		
2'-4' Depth Interval					
ARSENIC (AS) TOT			525	450	84
COPPER (CU) TOT			742	1400	280
CADMIUM (CD) TOT			90	135	16
LEAD (PB) TOT			5158	7750	593
ZINC (ZN) TOT			1647	3200	280
4'-6' Depth Interval					
ARSENIC (AS) TOT			182	150	
COPPER (CU) TOT			408	650	
CADMIUM (CD) TOT			69	48	
LEAD (PB) TOT			2435	3100	
ZINC (ZN) TOT			876	1150	
6-8' Depth Interval					
ARSENIC (AS) TOT			454	400	11
COPPER (CU) TOT			610	1650	28
CADMIUM (CD) TOT			69	240	<10
LEAD (PB) TOT			6029	20750	18
ZINC (ZN) TOT			1763	1400	55
8-10' Depth Interval					
ARSENIC (AS) TOT				10	14
COPPER (CU) TOT				22	28
CADMIUM (CD) TOT				1	<10
LEAD (PB) TOT				46	25
ZINC (ZN) TOT				48	41
10-12' Depth Interval					
ARSENIC (AS) TOT				11	24
COPPER (CU) TOT				31	41
CADMIUM (CD) TOT				2	<10
LEAD (PB) TOT				27	21
ZINC (ZN) TOT				38	51
19-21' Depth Interval					
ARSENIC (AS) TOT				40	15
COPPER (CU) TOT				52	61
CADMIUM (CD) TOT				2	<10
LEAD (PB) TOT				40	28
ZINC (ZN) TOT				77	53
25-26' Depth Interval					
ARSENIC (AS) TOT				450	41
COPPER (CU) TOT				63	66
CADMIUM (CD) TOT				55	13
LEAD (PB) TOT				25	38
ZINC (ZN) TOT				115	82

**TABLE 2-9. SUMMARY OF SOIL SAMPLE DATA - CRUSHING AND SAMPLE MILL AREA
(SAMPLE AREA 5)**

Sample Area Number	5				
Parameter	Surface Soil Sample Site Number			Monitoring Well Soil Sample Site Number	
	SS-20	UPS-SS4	UPS-SS5	DH-22	DH-43
30-32' Depth Interval					
ARSENIC (AS) TOT				250	231
COPPER (CU) TOT				165	57
CADMIUM (CD) TOT				65	55
LEAD (PB) TOT				105	22
ZINC (ZN) TOT				220	118
35-37' Depth Interval					
ARSENIC (AS) TOT				18	384
COPPER (CU) TOT				13	74
CADMIUM (CD) TOT				2	114
LEAD (PB) TOT				69	28
ZINC (ZN) TOT				67	345
40-41' Depth Interval					
ARSENIC (AS) TOT					98
COPPER (CU) TOT					50
CADMIUM (CD) TOT					104
LEAD (PB) TOT					30
ZINC (ZN) TOT					402

TOT = Total

All analytical values are in mg/Kg

Source: Appendices 2 and 7, Phase I RFI Report, ACI, 2003.

Note: Depth intervals have been normalized for comparison purposes. For example, the 4-6 foot increment in some samples may actually be a 3-5 foot sample increment. The actual sample increments are in the data reports included in Appendix A

Shading = No data available for these depth intervals

**TABLE 2-10. SUMMARY OF SOIL SAMPLE DATA - FORMER ZINC PLANT SHOP AND MEETING ROOM AREA
(SAMPLE AREA 7)**

Sample Area Number	7	
0"-4" Depth Interval	Monitoring Well Soil Sample Site Number	
Parameter	DH-23	DH-57
ARSENIC (AS) TOT		
COPPER (CU) TOT		
CADMIUM (CD) TOT		
LEAD (PB) TOT		
ZINC (ZN) TOT		
4"-12" Depth Interval		
ARSENIC (AS) TOT	73	67
COPPER (CU) TOT	365	39
CADMIUM (CD) TOT	15	10
LEAD (PB) TOT	1750	185
ZINC (ZN) TOT	10000	275
1'-2' Depth Interval		
ARSENIC (AS) TOT		
COPPER (CU) TOT		
CADMIUM (CD) TOT		
LEAD (PB) TOT		
ZINC (ZN) TOT		
2'-4' Depth Interval		
ARSENIC (AS) TOT	92	16
COPPER (CU) TOT	1300	25
CADMIUM (CD) TOT	11	1
LEAD (PB) TOT	9750	11
ZINC (ZN) TOT	52000	43
4'-6' Depth Interval		
ARSENIC (AS) TOT	123	15
COPPER (CU) TOT	2350	1
CADMIUM (CD) TOT	23	24
LEAD (PB) TOT	10750	9
ZINC (ZN) TOT	3950	53
6'-8' Depth Interval		
ARSENIC (AS) TOT	175	18
COPPER (CU) TOT	1850	29
CADMIUM (CD) TOT	22	1
LEAD (PB) TOT	17250	21
ZINC (ZN) TOT	44000	95
8'-10' Depth Interval		
ARSENIC (AS) TOT		14
COPPER (CU) TOT		30
CADMIUM (CD) TOT		2
LEAD (PB) TOT		18
ZINC (ZN) TOT		53
10'-12' Depth Interval		
ARSENIC (AS) TOT		
COPPER (CU) TOT		
CADMIUM (CD) TOT		
LEAD (PB) TOT		
ZINC (ZN) TOT		
19'-21' Depth Interval		
ARSENIC (AS) TOT		
COPPER (CU) TOT		
CADMIUM (CD) TOT		
LEAD (PB) TOT		
ZINC (ZN) TOT		
25'-26' Depth Interval		
ARSENIC (AS) TOT		
COPPER (CU) TOT		
CADMIUM (CD) TOT		
LEAD (PB) TOT		
ZINC (ZN) TOT		

**TABLE 2-10. SUMMARY OF SOIL SAMPLE DATA - FORMER ZINC PLANT SHOP AND MEETING ROOM AREA
(SAMPLE AREA 7)**

Sample Area Number	7	
0"-4" Depth Interval	Monitoring Well Soil Sample Site Number	
Parameter	DH-23	DH-57
30-32' Depth Interval		
ARSENIC (AS) TOT		
COPPER (CU) TOT		
CADMIUM (CD) TOT		
LEAD (PB) TOT		
ZINC (ZN) TOT		
35-37' Depth Interval		
ARSENIC (AS) TOT		
COPPER (CU) TOT		
CADMIUM (CD) TOT		
LEAD (PB) TOT		
ZINC (ZN) TOT		
40-41' Depth Interval		
ARSENIC (AS) TOT		
COPPER (CU) TOT		
CADMIUM (CD) TOT		
LEAD (PB) TOT		
ZINC (ZN) TOT		

TOT = Total

All analytical values are in mg/Kg

Source: Appendices 2 and 7, Phase I RFI Report, ACI, 2003.□

Note: Depth intervals have been normalized for comparison purposes. For example, the 4-6 foot increment in some samples may actually be a 3-5 foot sample increment. The actual sample increments are in the data reports included in Appendix A

Shading = No data available for these depth intervals

TABLE 3-1. PRIORITY OF MAINTENANCE TASKS

Priority	Type of Maintenance	Description and Example
1	Emergency	A situation requiring immediate attention (for example, fire or flood).
2	Preventative	Scheduled inspection and minor repairs carried out during inspection (for example, cleaning of membrane liner).
3	Corrective	Corrective maintenance required as a direct result of scheduled inspection (for example, repair of torn membrane liner).
4	Housekeeping	Routine housekeeping of buildings and grounds (for example, disposal of debris and general housekeeping).

**TABLE 3-2. EMERGENCY NOTIFICATION
CONTACTS AND PHONE NUMBERS**

General Emergency Numbers:

Fire Department	911
Ambulance	911
Police	911

Corporate Resources

ASARCO LLC

Blaine Cox	(East Helena Smelter)	(406) 227-4098
	Cell	(406) 459-8542
Jon Nickel	(East Helena Smelter)	(406) 227-4529

OTHER RESOURCES:

U.S. EPA (24-hour emergency)	(206) 553-1263
Superfund/RCRA Hotline	(800) 424-9346
Hydrometrics, Inc	(406) 443-4150

FIGURES

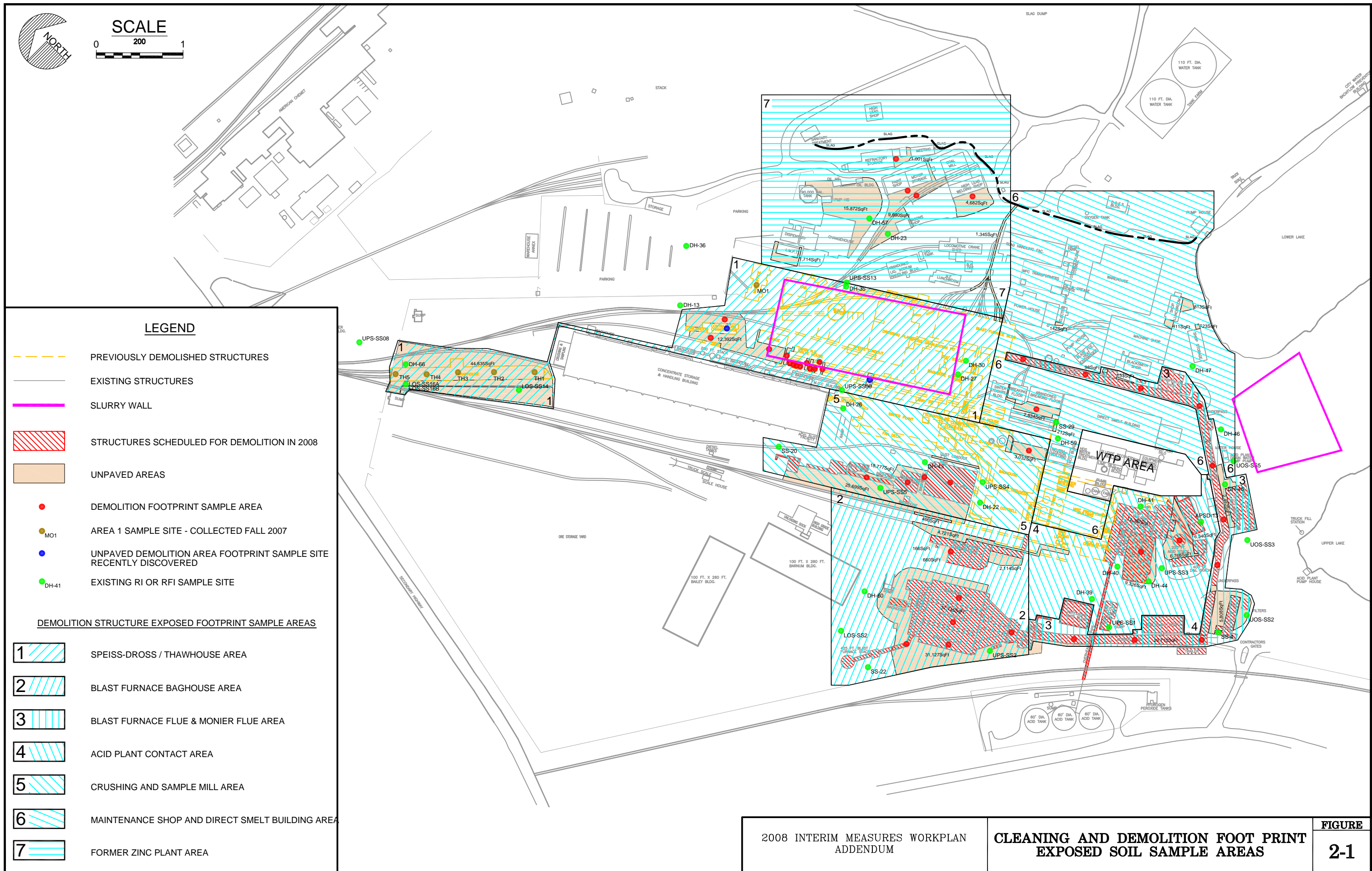
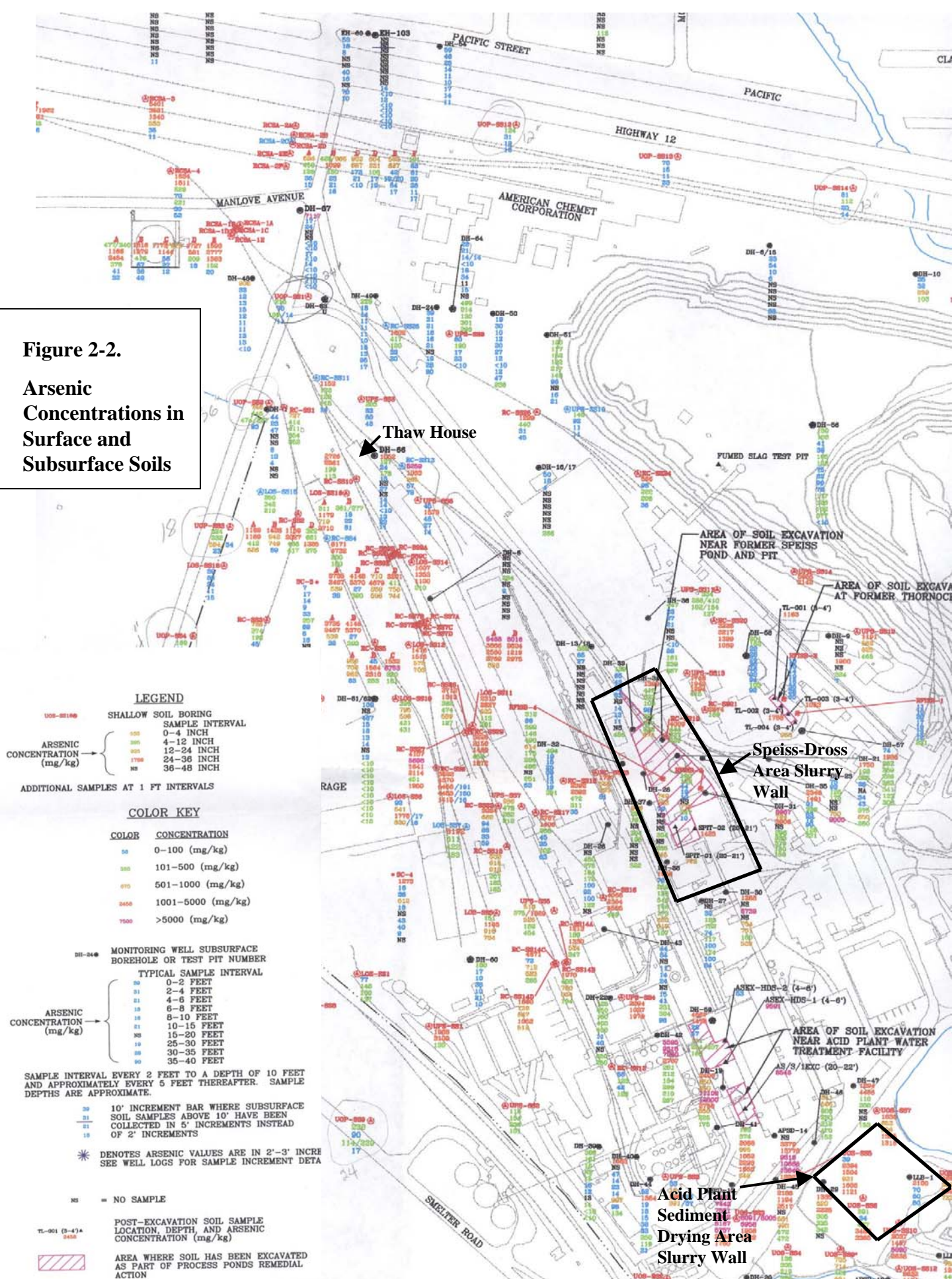
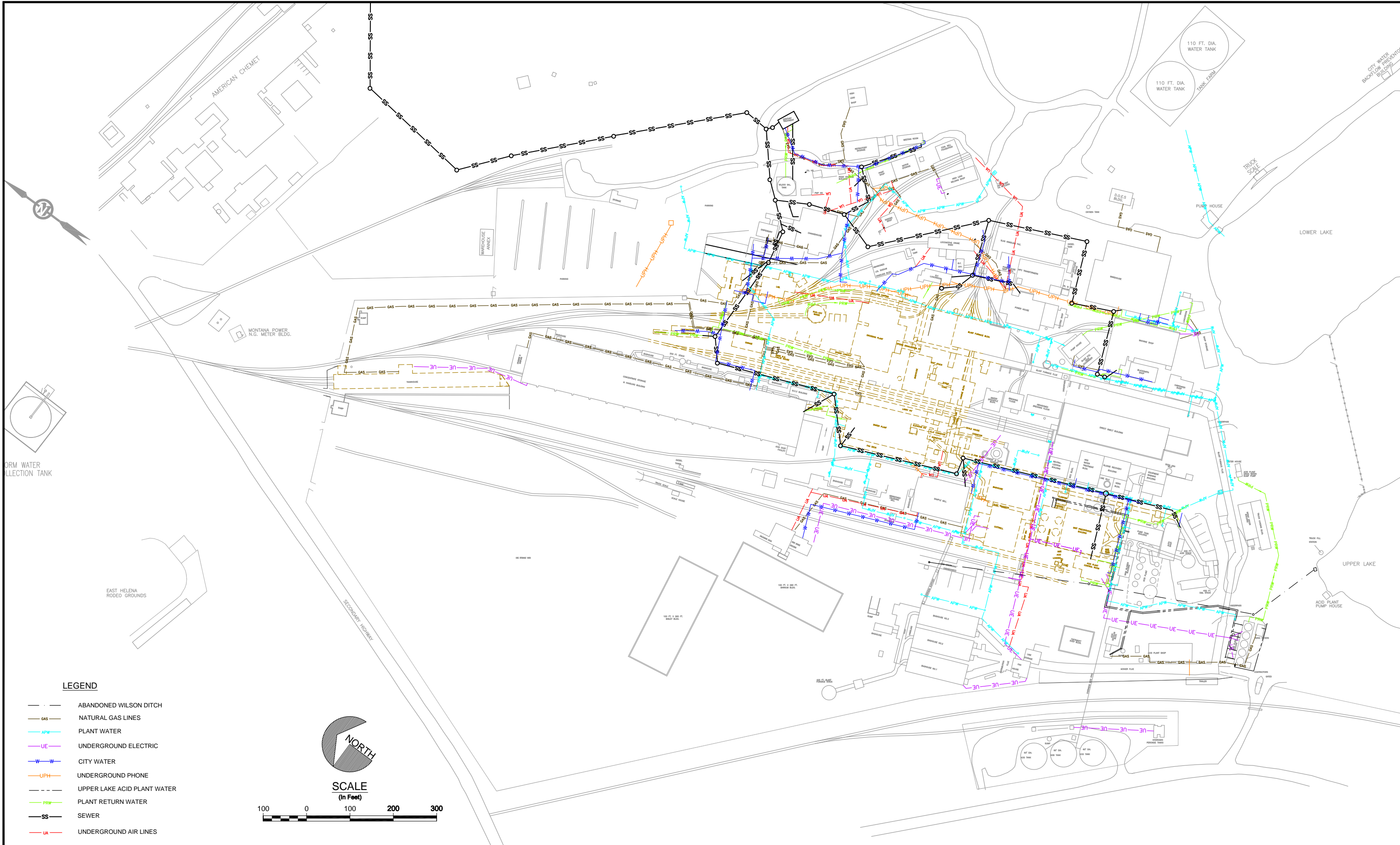


Figure 2-2.

Arsenic Concentrations in Surface and Subsurface Soils





LEGEND

- ABANDONED WILSON DITCH
- NATURAL GAS LINES
- PLANT WATER
- UNDERGROUND ELECTRIC
- CITY WATER
- UNDERGROUND PHONE
- UPPER LAKE ACID PLANT WATER
- PLANT RETURN WATER
- SEWER
- UNDERGROUND AIR LINES

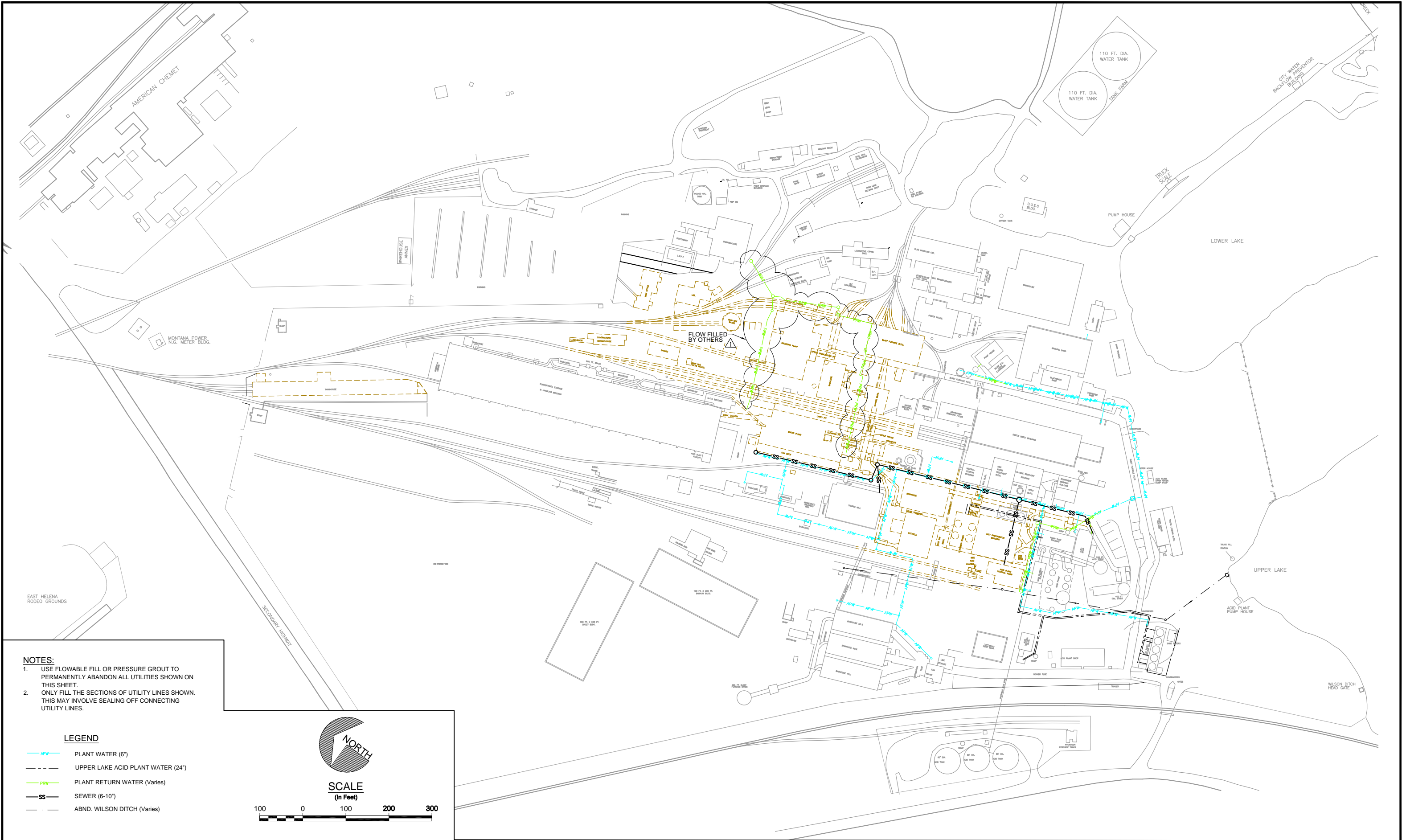
SCALE
(In Feet)

100 0 100 200 300

REVISIONS

NO	BY	DATE	DESCRIPTION

UPDATE TIME: 11:57AM
JSD\HCL\022608\Land Projects\705403\dwg\705403H016.dwg



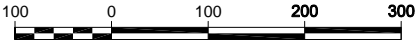
- NOTES:
- USE FLOWABLE FILL OR PRESSURE GROUT TO PERMANENTLY ABANDON ALL UTILITIES SHOWN ON THIS SHEET.
 - ONLY FILL THE SECTIONS OF UTILITY LINES SHOWN. THIS MAY INVOLVE SEALING OFF CONNECTING UTILITY LINES.

LEGEND

- APW PLANT WATER (6")
- UPPER LAKE ACID PLANT WATER (24")
- PRW PLANT RETURN WATER (Varies)
- SS SEWER (6-10")
- ABND. WILSON DITCH (Varies)



SCALE
(In Feet)



NO	BY	DATE	DESCRIPTION	NO	BY	DATE	DESCRIPTION

NO	BY	DATE	DESCRIPTION	NO	BY	DATE	DESCRIPTION

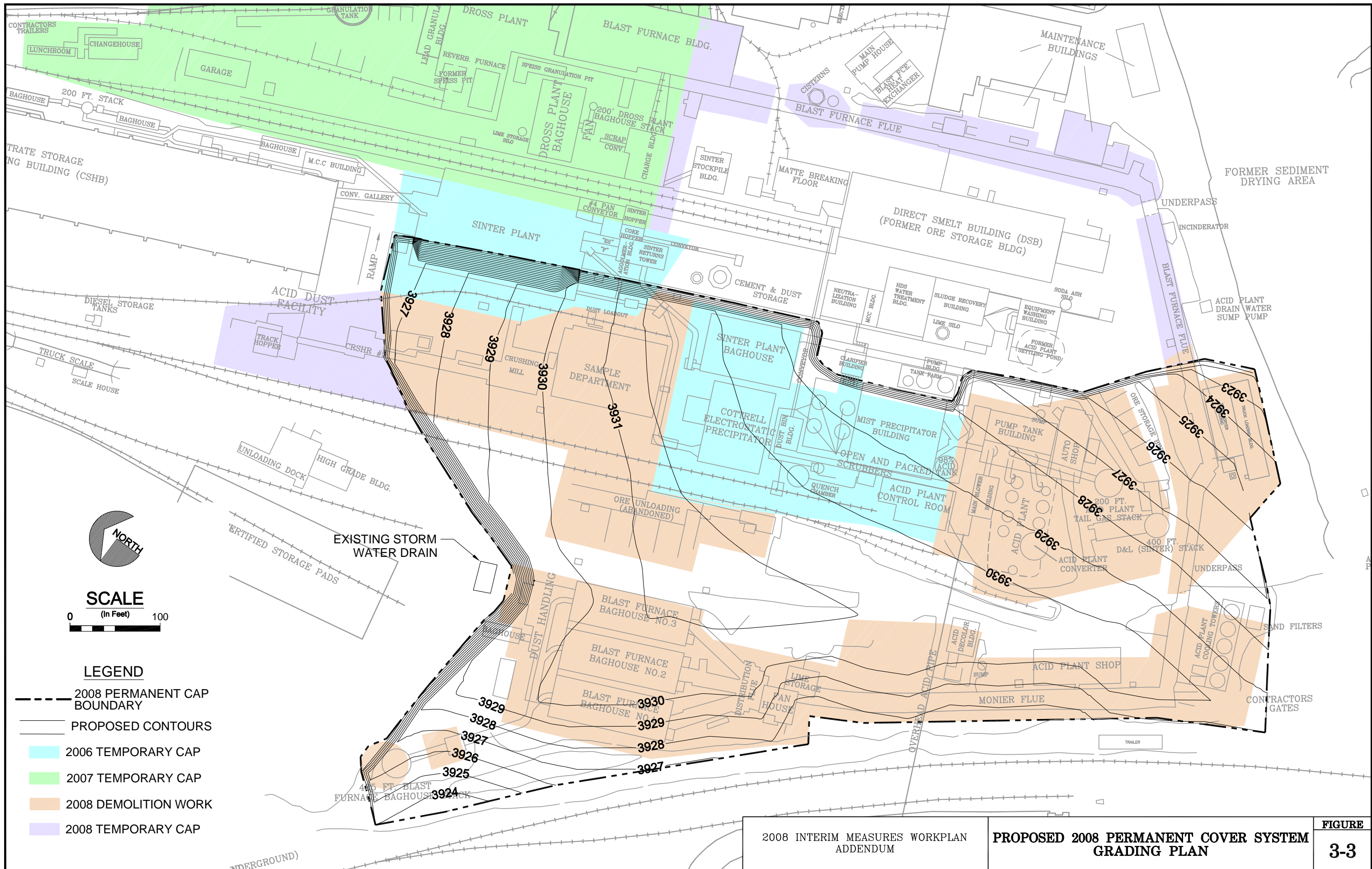
SCALE VERIFICATION
BAR IS ONE INCH ON
ORIGINAL DRAWING
0 1
IF NOT ONE INCH ON
THIS SHEET, ADJUST
SCALES ACCORDINGLY

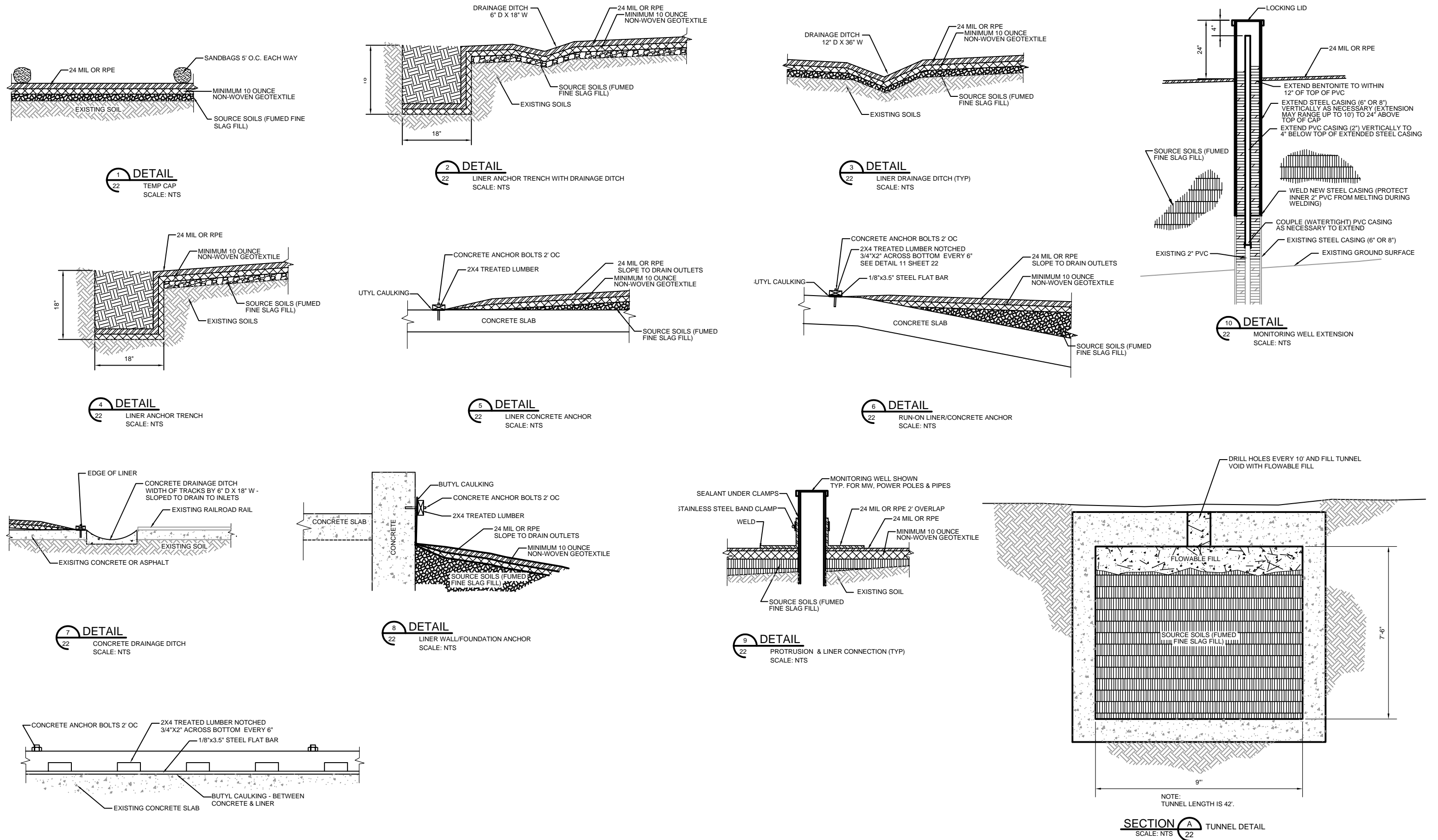
Project No.:	7054
DRAWN BY	GWL 1/19/07
CHECKED BY	MWR 1/19/07
APPROVED BY	MJO 1/24/07
SCALE:	1"=100'

Hydrometrics, Inc.
Consulting Scientists and Engineers
Helena, Montana 59601
3001 Broadway Avenue
(406) 443-4100

2008 INTERIM MEASURES WORK PLAN
UNDERGROUND UTILITIES
TO BE FLOW FILLED

DRAWING FILE NUMBER	
705403H017.dwg	
AUTOCAD 2004 DRAWING (DWG)	
FIGURE	REV
3-2	△



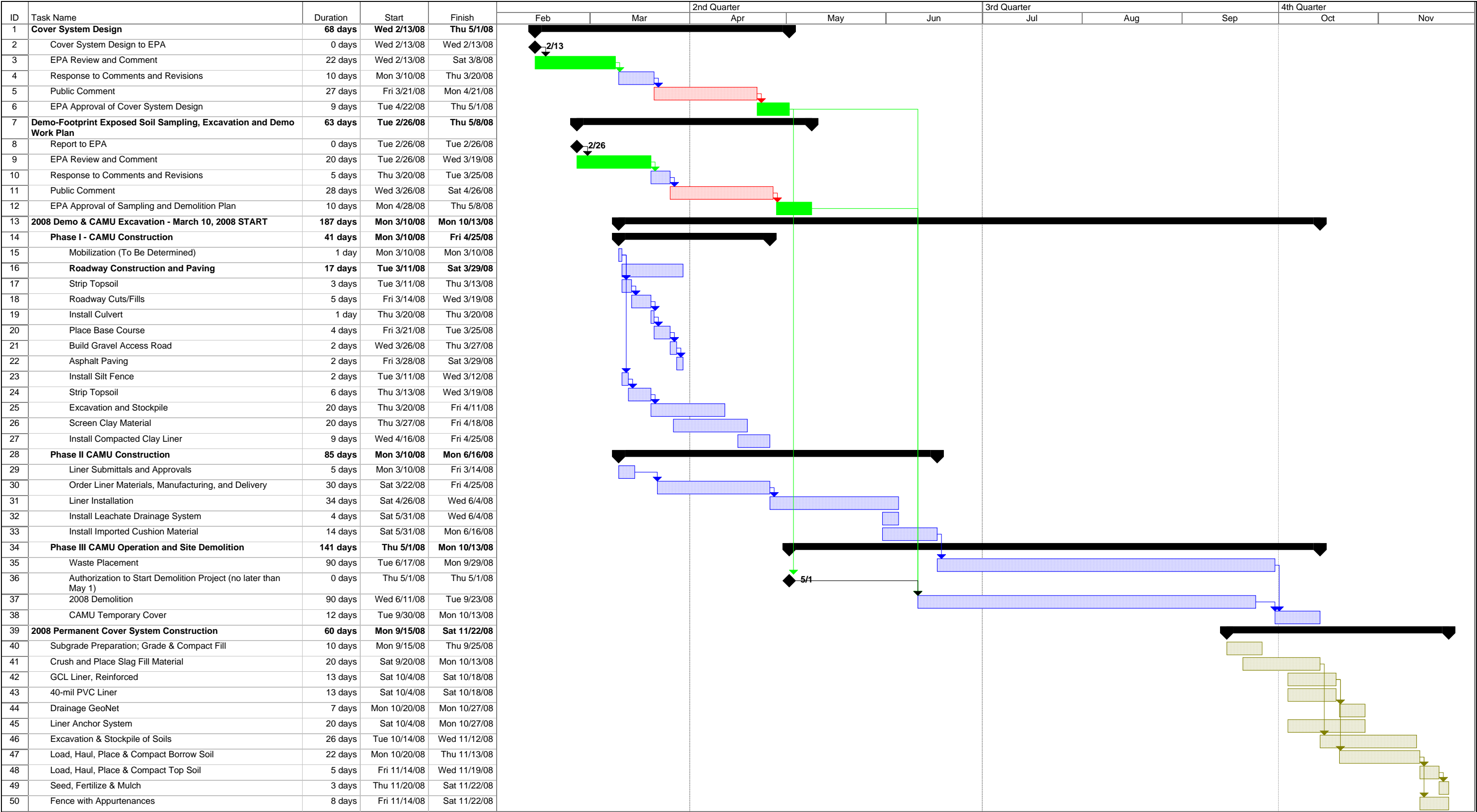


2008 INTERIM MEASURES WORKPLAN
ADDENDUM

TEMPORARY CAP DETAILS

FIGURE

3-4



Project: Cover System Design
Date: Mon 2/26/07

Task

Progress

Split

Milestone

Summary

Project Summary

External Tasks

External Milestone

Deadline



REVISIONS	NO	BY	DATE	DESCRIPTION	REVISIONS	NO	BY	DATE	SCALE VERIFICATION BAR IS ONE INCH ON ORIGINAL DRAWING 0 1 IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY	Project No.: 7054 DRAWN BY JSD 02/07/08 CHECKED BY APPROVED BY SCALE: 1"=100'	Hydrometrics, Inc. Consulting Scientists and Engineers Helena, Montana 59601 3020 Bozeman Avenue (406) 448-4180	2008 INTERIM MEASURES WORKPLAN ADDENDUM CLEANING AND DEMOLITION FOOT PRINT EXPOSED SOIL SAMPLE AREAS		DRAWING FILE NUMBER 705402H025.dwg AUTOCAD 2004 DRAWING (DWG) EXHIBIT 1 REV	

APPENDIX A

SURFACE AND SUB-SURFACE SOIL SAMPLE DATA FOR LOCATIONS NEAR DEMOLITION FOOT PRINT AREAS

-- SAMPLE TYPE: SOIL --

SITE CODE	UPS	UPS	UPS	UPS	UPS	UPS
SAMPLE DATE	03/20/2001	03/20/2001	03/20/2001	03/20/2001	03/20/2001	03/20/2001
SAMPLE TIME	12:45	09:00	09:05	09:10	09:10	09:15
LAB	RUSTON	RUSTON	RUSTON	RUSTON	TSC-SLC	RUSTON
LAB NUMBER	01R-00324	01R-00312	01R-00313	01R-00314	L011616028	01R-00315
TYPE					SPLP	
DEPTH	24-36"	0-4"	4-12"	12-24"	12-24"	24-36"
SAMPLE NUMBER	UPS-SS10-4	UPS-SS13-1	UPS-SS13-2	UPS-SS13-3	UPS-SS13-3	UPS-SS13-4

-- PHYSICAL PARAMETERS --

PH

8.1

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	11.0	1748.0	1924.0	1894.0	<0.1	415.0
CADMIUM (CD) TOT	< 10.0	843.0	501.0	312.0	<0.1	50.0
COPPER (CU) TOT	14.0	8221.0	7438.0	7092.0	<0.1	1695.0
LEAD (PB) TOT	23.0	14989.0	14334.0	19676.0	<0.1	9636.0
ZINC (ZN) TOT	15.0	8045.0	9131.0	13821.0	<0.1	41455.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

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-- SAMPLE TYPE: SOIL --

SITE CODE	UPS	UPS	UPS	UPS	UPS	UPS
SAMPLE DATE	03/20/2001	03/20/2001	03/20/2001	03/20/2001	03/20/2001	03/20/2001
SAMPLE TIME	14:35	14:40	14:40	14:45	14:50	13:00
LAB	RUSTON	RUSTON	TSC-SLC	RUSTON	RUSTON	RUSTON
LAB NUMBER	01R-00333	01R-00334	L011616026	01R-00335	01R-00339	01R-00325
REMARKS	DUPLICATE					
TYPE			SPLP			
DEPTH	0-4"	4-12"	4-12"	12-24"	24-36"	0-5"
SAMPLE NUMBER	UPS-SS01-1D	UPS-SS01-2	UPS-SS01-2	UPS-SS01-3	UPS-SS01-4	UPS-SS06-1

-- PHYSICAL PARAMETERS --

PH
7.3

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	394.0	1068.0	<0.1	3100.0	130.0	45.0
CADMIUM (CD) TOT	2690.0	901.0	1.5	213.0	107.0	92.0
COPPER (CU) TOT	851.0	9395.0	0.15	64908.0	437.0	179.0
LEAD (PB) TOT	8455.0	20116.0	0.41	64307.0	1483.0	630.0
ZINC (ZN) TOT	4425.0	11777.0	2.7	13830.0	912.0	350.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	UPS	UPS	UPS	UPS	UPS	UPS
SAMPLE DATE	03/20/2001	03/20/2001	03/20/2001	03/20/2001	03/20/2001	03/20/2001
SAMPLE TIME	13:05	13:10	13:15	13:20	10:30	10:35
LAB	RUSTON	RUSTON	RUSTON	RUSTON	RUSTON	RUSTON
LAB NUMBER	01R-00326	01R-00327	01R-00328	01R-00329	01R-00316	01R-00317
DEPTH	5-18"	18-28"	28-35"	35-48"	0-4"	4-12"
SAMPLE NUMBER	UPS-SS06-2	UPS-SS06-3	UPS-SS06-4	UPS-SS06-5	UPS-SS09-1	UPS-SS09-2

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	1879.0	48.0	27.0	14.0	60.0	190.0
CADMIUM (CD) TOT	701.0	28.0	17.0	< 10.0	31.0	35.0
COPPER (CU) TOT	3892.0	154.0	133.0	43.0	1296.0	796.0
LEAD (PB) TOT	24682.0	694.0	945.0	110.0	917.0	3064.0
ZINC (ZN) TOT	18867.0	605.0	532.0	103.0	1611.0	13786.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	UPS	UPS	UPS	UPS	UPS	UPS
SAMPLE DATE	03/15/2001	03/15/2001	03/15/2001	03/15/2001	03/15/2001	03/16/2001
SAMPLE TIME	12:15	12:15	12:20	12:25	12:30	10:00
LAB	RUSTON	TSC-SLC	RUSTON	RUSTON	RUSTON	RUSTON
LAB NUMBER	01R-00251	L011616027	01R-00252	01R-00253	01R-00254	01R-00275
TYPE		SPLP				
DEPTH	0-4"	0-4"	4-12"	12-24"	24-36"	0-4"
SAMPLE NUMBER	UPS-SS08-1	UPS-SS08-1	UPS-SS08-2	UPS-SS08-3	UPS-SS08-4	UPS-SS02-1

-- PHYSICAL PARAMETERS --

PH	8.6
----	-----

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	203.0	0.11	83.0	80.0	48.0	115.0
CADMIUM (CD) TOT	80.0	<0.1	48.0	33.0	28.0	433.0
COPPER (CU) TOT	787.0	<0.1	259.0	148.0	147.0	87.0
LEAD (PB) TOT	2624.0	<0.1	1169.0	913.0	722.0	573.0
ZINC (ZN) TOT	1347.0	<0.1	828.0	612.0	493.0	481.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

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-- SAMPLE TYPE: SOIL --

SITE CODE	LOS	LOS	LOS	LOS	LOS	LOS
SAMPLE DATE	03/15/2001	03/15/2001	03/15/2001	03/15/2001	03/15/2001	03/15/2001
SAMPLE TIME	14:00	14:00	14:05	13:00	13:05	13:10
LAB	RUSTON	TSC-SLC	RUSTON	RUSTON	RUSTON	RUSTON
LAB NUMBER	01R-00262	L011616020	01R-00263	01R-00255	01R-00256	01R-00257
TYPE		SPLP				
DEPTH	24-36"	24-36"	36-48"	0-4"	4-12"	12-24"
SAMPLE NUMBER	LOS-SS11-4	LOS-SS11-4	LOS-SS11-5	LOS-SS14-1	LOS-SS14-2	LOS-SS14-3

-- PHYSICAL PARAMETERS --

PH	7.5
----	-----

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	113.0	<0.1	291.0	1007.0	1353.0	1100.0
CADMIUM (CD) TOT	256.0	0.23	36.0	277.0	441.0	661.0
COPPER (CU) TOT	298.0	<0.1	612.0	1522.0	1888.0	1213.0
LEAD (PB) TOT	2502.0	<0.1	4199.0	7975.0	15362.0	12027.0
ZINC (ZN) TOT	2680.0	0.8	666.0	4387.0	6263.0	10971.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

--- SAMPLE TYPE: SOIL ---

SITE CODE	LOS	LOS	LOS	LOS	LOS	LOS
SAMPLE DATE	03/15/2001	03/15/2001	03/15/2001	03/15/2001	03/15/2001	04/05/2001
SAMPLE TIME	13:15	10:45	10:50	10:55	11:00	13:30
LAB	RUSTON	RUSTON	RUSTON	RUSTON	RUSTON	RUSTON
LAB NUMBER	01R-00258	01R-00247	01R-00248	01R-00249	01R-00250	01R-00585
DEPTH	24-36"	0-4"	4-12"	12-24"	24-36"	0-4"
SAMPLE NUMBER	LOS-SS14-4	LOS-SS16-1	LOS-SS16-2	LOS-SS16-3	LOS-SS16-4	LOS-SS01-1

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	210.0	311.0	1179.0	719.0	2710.0	77.0
CADMIUM (CD) TOT	40.0	109.0	628.0	356.0	564.0	< 10.0
COPPER (CU) TOT	425.0	1247.0	2736.0	762.0	1986.0	268.0
LEAD (PB) TOT	1760.0	2675.0	10217.0	3527.0	12936.0	396.0
ZINC (ZN) TOT	1715.0	7529.0	15239.0	4796.0	9604.0	833.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	LOS	LOS	LOS	LOS	LOS	LOS
SAMPLE DATE	04/06/2001	04/06/2001	04/06/2001	05/14/2001	05/14/2001	05/14/2001
SAMPLE TIME	10:05	10:10	10:15	08:30	08:40	08:50
LAB	RUSTON	RUSTON	RUSTON	RUSTON	RUSTON	RUSTON
LAB NUMBER	01R-00638	01R-00639	01R-00640	01R-01367	01R-01368	01R-01369
DEPTH	4-12"	12-24"	24-36"	0-2"	2-4"	4-6"
SAMPLE NUMBER	LOS-SS12-2	LOS-SS12-3	LOS-SS12-4	LOS-SS16A-1	LOS-SS16A-2	LOS-SS16A-3

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	1515.0	573.0	705.0	276.0	21.0	17.0
CADMIUM (CD) TOT	1078.0	682.0	222.0	208.0	< 10.0	< 10.0
COPPER (CU) TOT	962.0	223.0	1318.0	797.0	40.0	47.0
LEAD (PB) TOT	11790.0	3546.0	10999.0	3331.0	114.0	127.0
ZINC (ZN) TOT	9357.0	4017.0	11096.0	2668.0	96.0	123.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
R:Rejected.

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-- SAMPLE TYPE: SOIL --

SITE CODE	LOS	LOS	LOS	LOS	LOS	LOS
SAMPLE DATE	05/14/2001	05/14/2001	05/14/2001	05/14/2001	07/19/2001	07/19/2001
SAMPLE TIME	09:00	09:10	09:20	10:30	15:00	15:15
LAB	RUSTON	RUSTON	RUSTON	RUSTON	RUSTON	RUSTON
LAB NUMBER	01R-01370	01R-01371	01R-01372	01R-01373	01R-03750	01R-03751
REMARKS						DUPLICATE
DEPTH	6-8"	8-10"	10-12"	15-17"	0-2"	0-2"
SAMPLE NUMBER	LOS-SS16A-4	LOS-SS16A-5	LOS-SS16A-6	LOS-SS16A-7	LOS-SS16B-1	LOS-SS16B-1D

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	15.0	12.0	15.0	11.0	261.0	277.0
CADMIUM (CD) TOT	< 10.0	< 10.0	< 10.0	< 10.0	216.0	239.0
COPPER (CU) TOT	38.0	23.0	22.0	18.0	812.0	868.0
IRON (FE) (%) TOT					2.0	2.0
LEAD (PB) TOT	45.0	26.0	17.0	17.0	3361.0	3569.0
MANGANESE (MN) TOT					510.0	525.0
ZINC (ZN) TOT	74.0	55.0	57.0	42.0	3002.0	3234.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	LOS	LOS	LOS	LOS	LOS
SAMPLE DATE	07/19/2001	07/19/2001	07/19/2001	07/20/2001	07/20/2001
SAMPLE TIME	15:30	16:00	16:15	09:00	09:30
LAB	RUSTON	RUSTON	RUSTON	RUSTON	RUSTON
LAB NUMBER	01R-03752	01R-03753	01R-03754	01R-03757	01R-03758
DEPTH	2-4"	4-6"	10-12"	4-6"	10-12"
SAMPLE NUMBER	LOS-SS16B-2	LOS-SS16B-3	LOS-SS16B-4	LOS-SS06A-3	LOS-SS06A-4

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	18.0	22.0	81.0	17.0	16.0
CADMIUM (CD) TOT	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
COPPER (CU) TOT	23.0	35.0	24.0	32.0	16.0
IRON (FE) (%) TOT	2.0	2.0	2.0	2.0	3.0
LEAD (PB) TOT	47.0	29.0	25.0	34.0	18.0
MANGANESE (MN) TOT	331.0	434.0	378.0	456.0	262.0
ZINC (ZN) TOT	88.0	69.0	66.0	101.0	27.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

Surface Soil Sample Results - 1987 Phase II Investigation

Station #	Parameter											
	Ag	As	Cd	Cu	Hg	Cr	Mn	Pb	Sb	Se	Tl	Zn
SS-1	--	6075	6000	14575	240	22	1590	19350	980	423	182	23625
SS-2	209	3475	1813	3225	236	20	230	24975	107	518	118	10050
SS-3	64	1078	413	1090	--	19	400	10875	5	69	35	3075
SS-4	193	5650	14725	12175	104	23	890	23625	783	186	280	44050
SS-5	199	1495	1093	8850	2.2	27	--	21875	53	13	33	46625
SS-6	124	3300	253	4200	9.2	14	453	19400	5	13	59	3975
SS-7	157	3400	373	8500	4.5	12	195	22350	508	19	57	43725
SS-8	185	3800	1013	18600	15	30	1285	21400	189	71	29	14250
SS-10	197	3900	1613	8350	12	38	1823	23900	197	17	52	30425
SS-11	169	6525	5800	20700	17	36	2353	22100	1970	113	103	67175
SS-12	186	35500	5325	31450	--	27	2445	19975	1395	97	86	63650
SS-14	63	1098	212	1918	0.97	12	308	8900	206	21	9.9	30125
SS-15	30	385	172	9750	2	29	1858	3250	5	13	9.9	3975
SS-16	14	121	92	16375	0.75	14	338	1368	5	13	9.9	1868
SS-17	74	795	212	1813	0.87	15	220	6200	129	13	12	2235
SS-18	174	13450	23400	29200	70	86	2018	19325	2260	498	515	67175
SS-19	199	21625	2373	19850	--	46	11700	20250	1943	99	74	23300
SS-20	179	5450	1733	18625	0.6	27	1615	19225	2850	31	63	26275
SS-21	211	17075	1693	35350	--	79	950	22575	4950	221	52	14875
SS-22	201	3100	2213	11300	0.87	13	1083	21950	1770	13	76	23625
SS-23	12	121	212	320	--	26	410	11600	5	13	14	1093
SS-24	169	2115	613	4275	19	18	--	16575	5	13	33	7325
SS-28	214	8625	2525	23600	360	15	1703	1535	--	320	220	23925
SS-29	174	9525	2575	23700	90	27	2600	20300	4125	142	278	48550
SS-30	199	1633	373	5600	4	15	1510	12725	425	15	25	7925
SS-31	167	2625	813	6900	4.7	27	660	14600	81	33	27	84650

Notes: All concentrations reported in ug/g (dry wt.).
 Surface soil refers to soil sampled at a depth of 0-1 inches.

DRAFT
ANALYSES SUMMARY REPORT

-- SAMPLE TYPE: SOIL --

SITE CODE	LOS	LOS	LOS	LOS	LOS	LOS
SAMPLE DATE	04/05/2001	04/05/2001	04/05/2001	04/05/2001	04/05/2001	04/05/2001
SAMPLE TIME	13:35	13:40	13:45	14:30	14:35	14:40
LAB	RUSTON	RUSTON	RUSTON	RUSTON	RUSTON	RUSTON
LAB NUMBER	01R-00586	01R-00587	01R-00588	01R-00589	01R-00590	01R-00591
DEPTH	4-12"	12-24"	24-36"	0-4"	4-12"	12-24"
SAMPLE NUMBER	LOS-SS01-2	LOS-SS01-3	LOS-SS01-4	LOS-SS02-1	LOS-SS02-2	LOS-SS02-3

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	148.0	160.0	137.0	79.0	77.0	142.0
CADMIUM (CD) TOT	31.0	42.0	< 10.0	19.0	30.0	< 10.0
COPPER (CU) TOT	1520.0	1658.0	1873.0	136.0	248.0	1609.0
LEAD (PB) TOT	1333.0	2054.0	95.0	749.0	866.0	331.0
ZINC (ZN) TOT	5533.0	7180.0	7074.0	266.0	525.0	8332.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	LOS	LOS	LOS	LOS	LOS	LOS
SAMPLE DATE	04/05/2001	04/05/2001	04/05/2001	04/05/2001	04/05/2001	04/05/2001
SAMPLE TIME	14:45	15:00	15:05	15:10	15:15	15:15
LAB	RUSTON	RUSTON	RUSTON	RUSTON	RUSTON	TSC-SLC
LAB NUMBER	01R-00592	01R-00593	01R-00594	01R-00595	01R-00596	L011616023
TYPE						SPLP
DEPTH	24-36"	0-4"	4-12"	12-24"	24-36"	24-36"
SAMPLE NUMBER	LOS-SS02-4	LOS-SS05-1	LOS-SS05-2	LOS-SS05-3	LOS-SS05-4	LOS-SS05-4

-- PHYSICAL PARAMETERS --

PH

7.8

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	42.0	151.0	1195.0	916.0	784.0	92.0
CADMIUM (CD) TOT	< 10.0	329.0	2825.0	4686.0	2636.0	<0.1
COPPER (CU) TOT	378.0	795.0	5812.0	2414.0	4614.0	<0.1
LEAD (PB) TOT	146.0	2528.0	12178.0	15479.0	6854.0	<0.1
ZINC (ZN) TOT	1814.0	846.0	52306.0	11432.0	56395.0	<0.1

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	UPS	UPS	UPS	UPS	UPS	UPS
SAMPLE DATE	03/15/2001	03/15/2001	03/15/2001	03/15/2001	03/15/2001	03/16/2001
SAMPLE TIME	12:15	12:15	12:20	12:25	12:30	10:00
LAB	RUSTON	TSC-SLC	RUSTON	RUSTON	RUSTON	RUSTON
LAB NUMBER	01R-00251	L011616027	01R-00252	01R-00253	01R-00254	01R-00275
TYPE		SPLP				
DEPTH	0-4"	0-4"	4-12"	12-24"	24-36"	0-4"
SAMPLE NUMBER	UPS-SS08-1	UPS-SS08-1	UPS-SS08-2	UPS-SS08-3	UPS-SS08-4	UPS-SS02-1

-- PHYSICAL PARAMETERS --

PH	8.6
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-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	203.0	0.11	83.0	80.0	48.0	115.0
CADMIUM (CD) TOT	80.0	<0.1	48.0	33.0	28.0	433.0
COPPER (CU) TOT	787.0	<0.1	259.0	148.0	147.0	87.0
LEAD (PB) TOT	2624.0	<0.1	1169.0	913.0	722.0	573.0
ZINC (ZN) TOT	1347.0	<0.1	828.0	612.0	493.0	481.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	UPS	UPS	UPS	UPS	UPS	UPS
SAMPLE DATE	03/16/2001	03/16/2001	03/16/2001	03/16/2001	03/16/2001	03/16/2001
SAMPLE TIME	10:5	10:10	10:15	09:00	09:05	09:10
LAB	RUSTON	RUSTON	RUSTON	RUSTON	RUSTON	RUSTON
LAB NUMBER	01R-00276	01R-00277	01R-00278	01R-00268	01R-00269	01R-00270
REMARKS					DUPLICATE	
DEPTH	4-12"	12-24"	24-36"	0-4"	0-4"	4-12"
SAMPLE NUMBER	UPS-SS02-2	UPS-SS02-3	UPS-SS02-4	UPS-SS03-1	UPS-SS03-1D	UPS-SS03-2

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	140.0	236.0	101.0	33.0	33.0	16.0
CADMIUM (CD) TOT	79.0	179.0	< 10.0	64.0	80.0	24.0
COPPER (CU) TOT	39.0	82.0	27.0	94.0	111.0	43.0
LEAD (PB) TOT	193.0	619.0	26.0	578.0	649.0	261.0
ZINC (ZN) TOT	164.0	394.0	41.0	181.0	225.0	81.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

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ANALYSES SUMMARY REPORT

-- SAMPLE TYPE: SOIL --

SITE CODE	UPS	UPS	UPS	UPS	UPS	UPS
SAMPLE DATE	03/16/2001	03/16/2001	03/16/2001	03/16/2001	03/16/2001	03/20/2001
SAMPLE TIME	14:30	15:00	15:05	15:10	15:10	14:30
LAB	RUSTON	RUSTON	RUSTON	RUSTON	RUSTON	RUSTON
LAB NUMBER	01R-00307	01R-00308	01R-00309	01R-00310	01R-00311	01R-00332
DEPTH	24-36"	0-4"	4-12"	12-24"	24-36"	0-4"
SAMPLE NUMBER	UPS-SS11-4	UPS-SS12-1	UPS-SS12-2	UPS-SS12-3	UPS-SS12-4	UPS-SS01-1

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	137.0	1191.0	862.0	625.0	465.0	437.0
CADMIUM (CD) TOT	< 10.0	192.0	124.0	75.0	79.0	3069.0
COPPER (CU) TOT	71.0	4101.0	3298.0	2453.0	2074.0	690.0
LEAD (PB) TOT	449.0	14172.0	8246.0	5127.0	5595.0	8813.0
ZINC (ZN) TOT	288.0	12858.0	26980.0	22123.0	24333.0	4628.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	UPS	UPS	UPS	UPS	UPS	UPS
SAMPLE DATE	03/20/2001	03/20/2001	03/20/2001	03/20/2001	03/20/2001	03/20/2001
SAMPLE TIME	14:35	14:40	14:40	14:45	14:50	13:00
LAB	RUSTON	RUSTON	TSC-SLC	RUSTON	RUSTON	RUSTON
LAB NUMBER	01R-00333	01R-00334	L011616026	01R-00335	01R-00339	01R-00325
REMARKS	DUPLICATE					
TYPE			SPLP			
DEPTH	0-4"	4-12"	4-12"	12-24"	24-36"	0-5"
SAMPLE NUMBER	UPS-SS01-1D	UPS-SS01-2	UPS-SS01-2	UPS-SS01-3	UPS-SS01-4	UPS-SS06-1

-- PHYSICAL PARAMETERS --

PH	7.3
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-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	394.0	1068.0	<0.1	3100.0	130.0	45.0
CADMIUM (CD) TOT	2690.0	901.0	1.5	213.0	107.0	92.0
COPPER (CU) TOT	851.0	9395.0	0.15	64908.0	437.0	179.0
LEAD (PB) TOT	8455.0	20116.0	0.41	64307.0	1483.0	630.0
ZINC (ZN) TOT	4425.0	11777.0	2.7	13830.0	912.0	350.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	UOS	UOS	UOS	UOS	UOS	UOS
SAMPLE DATE	04/17/2001	04/17/2001	04/17/2001	04/17/2001	04/17/2001	04/17/2001
SAMPLE TIME	11:55	12:00	12:05	12:10	11:15	11:20
LAB	RUSTON	RUSTON	RUSTON	RUSTON	RUSTON	RUSTON
LAB NUMBER	01R-00805	01R-00806	01R-00807	01R-00808	01R-00798	01R-00799
DEPTH	4-12"	12-24"	24-36"	36-60"	0-4"	4-12"
SAMPLE NUMBER	UOS-SS01-2	UOS-SS01-3	UOS-SS01-4	UOS-SS01-5	UOS-SS02-1	UOS-SS02-2

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	752.0	375.0	13.0	15.0	3121.0	382.0
CADMIUM (CD) TOT	473.0	553.0	15.0	13.0	10646.0	1894.0
COPPER (CU) TOT	966.0	671.0	28.0	22.0	3346.0	663.0
LEAD (PB) TOT	10287.0	6297.0	89.0	60.0	28537.0	5230.0
ZINC (ZN) TOT	4144.0	2534.0	81.0	49.0	19494.0	3177.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

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ANALYSES SUMMARY REPORT

-- SAMPLE TYPE: SOIL --

SITE CODE	UOS	UOS	UOS	UOS	UOS	UOS
SAMPLE DATE	04/17/2001	04/17/2001	04/17/2001	04/17/2001	04/17/2001	04/17/2001
SAMPLE TIME	11:25	11:30	11:35	15:00	15:05	15:10
LAB	RUSTON	RUSTON	RUSTON	RUSTON	RUSTON	RUSTON
LAB NUMBER	01R-00800	01R-00801	01R-00802	01R-00894	01R-00895	01R-00896
DEPTH	12-24"	24-36"	36-60"	0-4"	4-12"	12-24"
SAMPLE NUMBER	UOS-SS02-3	UOS-SS02-4	UOS-SS02-5	UOS-SS05-1	UOS-SS05-2	UOS-SS05-3

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	1481.0	122.0	165.0	39.0 J2	2394.0 J2	1504.0 J2
CADMIUM (CD) TOT	1113.0	262.0	497.0	40.0	346.0	455.0
COPPER (CU) TOT	2587.0	197.0	235.0	88.0	2075.0	2059.0
LEAD (PB) TOT	25628.0	2699.0	2238.0	376.0	13621.0	12560.0
ZINC (ZN) TOT	10028.0	848.0	1000.0	137.0	4298.0	3830.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	UOS	UOS	UOS	UOS	UOS	UOS
SAMPLE DATE	04/26/2001	04/26/2001	04/26/2001	04/27/2001	04/27/2001	04/27/2001
SAMPLE TIME	15:15	15:20	15:25	09:30	09:35	09:40
LAB	RUSTON	RUSTON	RUSTON	RUSTON	RUSTON	RUSTON
LAB NUMBER	01R-01239	01R-01240	01R-01241	01R-01247	01R-01248	01R-01249
REMARKS					DUPLICATE	
DEPTH	12-24"	24-48"	48-56"	0-4"	0-4"	4-12"
SAMPLE NUMBER	UOS-SS9-3	UOS-SS9-4	UOS-SS9-5	UOS-SS03-1	UOS-SS03-1D	UOS-SS03-2

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	714.0	429.0	661.0	8091.0	8005.0	6958.0
CADMIUM (CD) TOT	42.0	72.0	< 10.0	9319.0	7205.0	4012.0
COPPER (CU) TOT	3015.0	570.0	530.0	23599.0	26721.0	11639.0
LEAD (PB) TOT	6338.0	1093.0	1203.0	71196.0	70553.0	66080.0
ZINC (ZN) TOT	11313.0	1603.0	1266.0	34579.0	30190.0	16607.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

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ANALYSES SUMMARY REPORT

-- SAMPLE TYPE: SOIL --

SITE CODE	UOS	UOS	UOS	UOS	UOS	UOS
SAMPLE DATE	04/27/2001	04/27/2001	10/03/2001	10/03/2001	10/03/2001	10/03/2001
SAMPLE TIME	09:45	09:50	10:15	10:20	10:30	10:40
LAB	RUSTON	RUSTON	RUSTON	RUSTON	RUSTON	RUSTON
LAB NUMBER	01R-01250	01R-01251	01R-06804	01R-06805	01R-06806	01R-06807
DEPTH	12-24"	24-36"	0-4"	4-12"	12-24"	24-36"
SAMPLE NUMBER	UOS-SS03-3	UOS-SS03-4	UOS-SS10-1	UOS-SS10-2	UOS-SS10-3	UOS-SS10-4

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	1908.0	1022.0	3037.0	1457.0	5080.0	2638.0
CADMIUM (CD) TOT	1009.0	1847.0	844.0	493.0	1306.0	1391.0
COPPER (CU) TOT	2622.0	6447.0	4089.0	2503.0	3156.0	3107.0
LEAD (PB) TOT	16145.0	11327.0	19221.0	11734.0	26662.0	20362.0
ZINC (ZN) TOT	6833.0	12249.0	9197.0	5283.0	5413.0	10508.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	UOS	UOS	UOS	UOS	UOS	UOS
SAMPLE DATE	04/17/2001	04/17/2001	04/17/2001	04/17/2001	04/17/2001	04/17/2001
SAMPLE TIME	11:25	11:30	11:35	15:00	15:05	15:10
LAB	RUSTON	RUSTON	RUSTON	RUSTON	RUSTON	RUSTON
LAB NUMBER	01R-00800	01R-00801	01R-00802	01R-00894	01R-00895	01R-00896
DEPTH	12-24"	24-36"	36-60"	0-4"	4-12"	12-24"
SAMPLE NUMBER	UOS-SS02-3	UOS-SS02-4	UOS-SS02-5	UOS-SS05-1	UOS-SS05-2	UOS-SS05-3

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	1481.0	122.0	165.0	39.0 J2	2394.0 J2	1504.0 J2
CADMIUM (CD) TOT	1113.0	262.0	497.0	40.0	346.0	455.0
COPPER (CU) TOT	2587.0	197.0	235.0	88.0	2075.0	2059.0
LEAD (PB) TOT	25628.0	2699.0	2238.0	376.0	13621.0	12560.0
ZINC (ZN) TOT	10028.0	848.0	1000.0	137.0	4298.0	3830.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

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ANALYSES SUMMARY REPORT

-- SAMPLE TYPE: SOIL --

SITE CODE	UOS	UOS	UOS	UOS	UOS	UOS
SAMPLE DATE	04/17/2001	04/17/2001	04/17/2001	04/17/2001	04/17/2001	04/17/2001
SAMPLE TIME	15:15	15:20	15:25	14:00	14:05	14:10
LAB	RUSTON	RUSTON	RUSTON	RUSTON	RUSTON	RUSTON
LAB NUMBER	01R-00897	01R-00898	01R-00899	01R-00888	01R-00889	01R-00890
REMARKS					DUPLICATE	
DEPTH	24-36"	36-60"	60-72"	0-4"	0-4"	4-12"
SAMPLE NUMBER	UOS-SS05-4	UOS-SS05-5	UOS-SS05-6	UOS-SS07-1	UOS-SS07-1D	UOS-SS07-2

-- METALS & MINOR CONSTITUENTS --

	UOS	J2	UOS	J2	UOS	J2	UOS	J2	UOS	J2
ARSENIC (AS) TOT	931.0	J2	1608.0	J2	475.0	J2	1636.0	J2	1874.0	J2
CADMIUM (CD) TOT	497.0		1367.0		148.0		654.0		638.0	
COPPER (CU) TOT	736.0		1492.0		295.0		6354.0		7099.0	
LEAD (PB) TOT	8720.0		15928.0		1970.0		20323.0		21805.0	
ZINC (ZN) TOT	2944.0		7173.0		1121.0		5105.0		5298.0	

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	DH-59	DH-59	DH-60	DH-60	DH-60
SAMPLE DATE	05/23/2001	05/23/2001	05/12/2001	05/12/2001	05/12/2001
SAMPLE TIME	18:20	18:50	10:55	18:25	19:05
LAB	TSC-SLC	TSC-SLC	RUSTON	RUSTON	RUSTON
LAB NUMBER	L010788008	L010788009	01R-01409	01R-01419	01R-01420
REMARKS	DUPLICATE				
DEPTH	20-22'	25-27'	0-2'	30-32'	35-37'
SAMPLE NUMBER	DH-59-8D	DH-59-9	DH-60-1	DH-60-10	DH-60-11

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	207.0	169.0	180.0	< 10.0	13.0
BERYLLIUM (BE) TOT	<2.0	<2.0			
CADMIUM (CD) TOT	336.0	60.0	643.0	< 10.0	< 10.0
COPPER (CU) TOT	82.0	67.0	718.0	31.0	27.0
IRON (FE) (%) TOT	1.8	2.5	3.0	1.0	4.0
LEAD (PB) TOT	172.0	262.0	2819.0	58.0	62.0
MANGANESE (MN) TOT	168.0	218.0	489.0	426.0	559.0
MERCURY (HG) TOT	2.8 J4	0.11 J4			
SELENIUM (SE) TOT	<10.0	<10.0			
SILVER (AG) TOT	<10.0	<10.0			
THALLIUM (TL) TOT	27.0	16.0			
ZINC (ZN) TOT	178.0 J2	159.0 J2	1699.0	83.0	120.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

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-- SAMPLE TYPE: SOIL --

SITE CODE	DH-60	DH-60	DH-60	DH-60	DH-60	DH-60
SAMPLE DATE	05/12/2001	05/12/2001	05/12/2001	05/12/2001	05/12/2001	05/12/2001
SAMPLE TIME	11:00	11:10	11:20	12:00	12:30	16:30
LAB	RUSTON	RUSTON	RUSTON	RUSTON	RUSTON	RUSTON
LAB NUMBER	01R-01410	01R-01411	01R-01412	01R-01413	01R-01414	01R-01415
DEPTH	2-4'	4-6'	6-8'	8-10'	10-12'	15-17'
SAMPLE NUMBER	DH-60-2	DH-60-3	DH-60-4	DH-60-5	DH-60-6	DH-60-7

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	17.0	70.0	38.0	< 10.0	21.0	< 10.0
CADMIUM (CD) TOT	19.0	215.0	98.0	< 10.0	19.0	< 10.0
COPPER (CU) TOT	37.0	314.0	119.0	27.0	56.0	50.0
IRON (FE) (%) TOT	2.0	3.0	3.0	3.0	4.0	3.0
LEAD (PB) TOT	70.0	945.0	417.0	39.0	145.0	35.0
MANGANESE (MN) TOT	407.0	414.0	503.0	639.0	617.0	598.0
ZINC (ZN) TOT	148.0	483.0	339.0	40.0	110.0	38.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	DH-60	DH-60	DH-60	DH-61	DH-61
SAMPLE DATE	05/12/2001	05/12/2001	05/12/2001	05/08/2001	05/08/2001
SAMPLE TIME	16:35	17:00	17:40	14:45	15:00
LAB	RUSTON	RUSTON	RUSTON	RUSTON	RUSTON
LAB NUMBER	01R-01416	01R-01417	01R-01418	01R-01390	01R-01391
REMARKS	DUPLICATE				
DEPTH	15-17'	20-22'	25-27'	0-2'	2-6'
SAMPLE NUMBER	DH-60-7D	DH-60-8	DH-60-9	DH-61-1	DH-61-3

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	< 10.0	< 10.0	< 10.0	109.0	467.0
CADMIUM (CD) TOT	< 10.0	< 10.0	< 10.0	29.0	68.0
COPPER (CU) TOT	43.0	30.0	18.0	132.0	1174.0
IRON (FE) (†) TOT	3.0	3.0	1.0	2.0	3.0
LEAD (PB) TOT	29.0	56.0	51.0	837.0	9519.0
MANGANESE (MN) TOT	636.0	835.0	376.0	611.0	1081.0
ZINC (ZN) TOT	46.0	85.0	81.0	595.0	10768.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

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-- SAMPLE TYPE: SOIL --

SITE CODE	DH-39	DH-39	DH-39	DH-39	DH-39	DH-39
SAMPLE DATE	11/16/1999	11/16/1999	11/16/1999	11/16/1999	11/16/1999	11/16/1999
SAMPLE TIME	15:15	15:30	15:40	16:05	16:15	16:45
LAB	EHLAB	EHLAB	EHLAB	EHLAB	EHLAB	EHLAB
LAB NUMBER	99X-05000	99X-05001	99X-05002	99X-05003	99X-05004	99X-05005
TYPE	XRF	XRF	XRF	XRF	XRF	XRF
DEPTH	1-3'	3-5'	5-7'	9-11'	11-13'	15-16.5'
SAMPLE NUMBER	IMMS-9910-310	IMMS-9910-311	IMMS-9910-312	IMMS-9910-313	IMMS-9910-314	IMMS-9910-315

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	386.0	131.0	13.0	14.0	18.0	12.0
CADMIUM (CD) TOT	426.0	17.0	< 10.0	< 10.0	< 10.0	< 10.0
COPPER (CU) TOT	3487.0	2007.0	32.0	33.0	29.0	38.0
IRON (FE) (%) TOT	11.0	14.0	3.0	2.0	3.0	3.0
LEAD (PB) TOT	1801.0	146.0	33.0	15.0	< 10.0	24.0
MANGANESE (MN) TOT	2940.0	5190.0	1438.0	335.0	611.0	473.0
ZINC (ZN) TOT	10803.0	16578.0	1134.0	62.0	56.0	57.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	DH-39	DH-39	DH-39	DH-39	DH-39
SAMPLE DATE	11/16/1999	11/17/1999	11/17/1999	11/17/1999	11/17/1999
SAMPLE TIME	17:20	9:00	9:30	9:45	10:00
LAB	EHLAB	EHLAB	EHLAB	EHLAB	EHLAB
LAB NUMBER	99X-05006	99X-05107	99X-05108	99X-05109	99X-05110
REMARKS				DUPLICATE	
TYPE	XRF	XRF	XRF	XRF	XRF
DEPTH	20-21.5'	25-26.5'	30-31.5'	30-31.5'	35-36.5'
SAMPLE NUMBER	IMMS-9910-316	IMMS-9910-317	IMMS-9910-318	IMMS-9910-318D	IMMS-9910-319

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	13.0	14.0	< 10.0	10.0	< 10.0
CADMIUM (CD) TOT	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
COPPER (CU) TOT	66.0	55.0	35.0	34.0	44.0
IRON (FE) (%) TOT	2.0	3.0	2.0	2.0	2.0
LEAD (PB) TOT	25.0	65.0	78.0	72.0	65.0
MANGANESE (MN) TOT	579.0	656.0	953.0	1014.0	263.0
ZINC (ZN) TOT	53.0	86.0	109.0	110.0	91.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

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-- SAMPLE TYPE: SOIL --

SITE CODE	DH-45	DH-45	DH-45	DH-45	DH-45	DH-45
SAMPLE DATE	11/10/1999	11/10/1999	11/10/1999	11/12/1999	11/12/1999	11/12/1999
SAMPLE TIME	10:15	11:40	11:45	9:30	10:00	11:40
LAB	EHLAB	EHLAB	EHLAB	EHLAB	EHLAB	EHLAB
LAB NUMBER	99X-04979	99X-04980	99X-04981	99X-04982	99X-04983	99X-04984
TYPE	XRF	XRF	XRF	XRF	XRF	XRF
DEPTH	0.5-2.0'	3-5'	5-7'	8-10'	10-12'	15-17'
SAMPLE NUMBER	IMMS-9910-240	IMMS-9910-241	IMMS-9910-242	IMMS-9910-243	IMMS-9910-244	IMMS-9910-245

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	2186.0	1194.0	2517.0	561.0	793.0	472.0
CADMIUM (CD) TOT	355.0	118.0	243.0	138.0	129.0	816.0
COPPER (CU) TOT	4139.0	1062.0	3005.0	399.0	281.0	71.0
IRON (FE) (%) TOT	6.0	4.0	6.0	3.0	3.0	3.0
LEAD (PB) TOT	9224.0	3381.0	7468.0	1282.0	765.0	186.0
MANGANESE (MN) TOT	629.0	504.0	798.0	839.0	457.0	444.0
ZINC (ZN) TOT	5629.0	3674.0	5287.0	928.0	549.0	2790.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	DH-46	DH-46	DH-46	DH-46	DH-46	DH-46
SAMPLE DATE	11/23/1999	11/23/1999	11/23/1999	11/23/1999	11/23/1999	11/23/1999
SAMPLE TIME	10:45	10:50	10:55	11:15	11:45	14:00
LAB	EHLAB	EHLAB	EHLAB	EHLAB	EHLAB	EHLAB
LAB NUMBER	99X-05163	99X-05164	99X-05165	99X-05166	99X-05167	99X-05168
REMARKS		DUPLICATE				
TYPE	XRF	XRF	XRF	XRF	XRF	XRF
DEPTH	0.5-2.5'	0.5-2.5'	2.5-4.5'	4.5-6.5'	6.5-8.5'	8.5-10.5'
SAMPLE NUMBER	IMMS-9910-282	IMMS-9910-282D	IMMS-9910-283	IMMS-9910-284	IMMS-9910-285	IMMS-9910-286

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	611.0	526.0	595.0	308.0	250.0	218.0
CADMIUM (CD) TOT	148.0	138.0	93.0	37.0	< 10.0	22.0
COPPER (CU) TOT	660.0	549.0	643.0	329.0	282.0	270.0
IRON (FE) (%) TOT	2.0	2.0	3.0	3.0	3.0	3.0
LEAD (PB) TOT	2734.0	2439.0	1794.0	1235.0	1658.0	1032.0
MANGANESE (MN) TOT	518.0	515.0	533.0	473.0	467.0	492.0
ZINC (ZN) TOT	952.0	856.0	527.0	270.0	391.0	375.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	DH-46	DH-46	DH-47	DH-47	DH-47
SAMPLE DATE	11/23/1999	11/23/1999	11/15/1999	11/15/1999	11/15/1999
SAMPLE TIME	14:30	15:00	10:30	10:45	10:50
LAB	EHLAB	EHLAB	EHLAB	EHLAB	EHLAB
LAB NUMBER	99X-05169	99X-05170	99X-04985	99X-04986	99X-04987
TYPE	XRF	XRF	XRF	XRF	XRF
DEPTH	10.5-12.5'	15-17'	0.5-2.5'	2.5-4.5'	4.5-6.5'
SAMPLE NUMBER	IMMS-9910-287	IMMS-9910-288	IMMS-9910-246	IMMS-9910-247	IMMS-9910-248

-- METALS & MINOR CONSTITUENTS --

	DH-46	DH-46	DH-47	DH-47	DH-47
ARSENIC (AS) TOT	470.0	153.0	1294.0	4456.0	110.0
CADMIUM (CD) TOT	31.0	< 10.0	298.0	222.0	< 10.0
COPPER (CU) TOT	315.0	88.0	1090.0	1951.0	58.0
IRON (FE) (%) TOT	3.0	3.0	5.0	7.0	3.0
LEAD (PB) TOT	914.0	47.0	5153.0	10372.0	201.0
MANGANESE (MN) TOT	441.0	448.0	555.0	3977.0	595.0
ZINC (ZN) TOT	296.0	123.0	1597.0	15060.0	292.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	DH-29S	DH-29S	DH-29S	DH-30	DH-30
SAMPLE DATE	12/11/1987	12/11/1987	12/11/1987	11/20/1999	11/20/1999
SAMPLE TIME				14:00	14:35
LAB	TSC-SLC	TSC-SLC	VERSR	EHLAB	EHLAB
LAB NUMBER				99X-05094	99X-05095
REMARKS			SPLIT		
TYPE	TOTAL	TOTAL	TOTAL	XRF	XRF
DEPTH	8-10	10-12	10-12	1-3'	3.5-5.5'
SAMPLE NUMBER	HYD-8107.A14	HYD-8108.A14	HYD-8109.A14	IMMS-9910-270	IMMS-9910-271

-- PHYSICAL PARAMETERS --

PH	6.9	6.9
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-- MAJOR CONSTITUENTS --

MAGNESIUM (MG) DIS	3410.0
SODIUM (NA) DIS	658.0
POTASSIUM (K) DIS	1990.0

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	335.0	342.0	1288.0	6739.0
CADMIUM (CD) TOT	40.0	27.0	234.0	3011.0
COPPER (CU) TOT	578.0	1058.0	4970.0	111.0
IRON (FE) TOT	18610.0	45325.0	37000.0	
IRON (FE) (%) TOT			10.0	2.0
LEAD (PB) TOT	5070.0	9523.0	6330.0	11574.0
MANGANESE (MN) TOT	625.0	2748.0	2190.0	3985.0
MERCURY (HG) TOT			6.6	458.0
NICKEL (NI) TOT			12.0	
ZINC (ZN) TOT	3250.0	9350.0	26012.0	1082.0

-- OTHER PARAMETERS --

COARSE FRAGMENTS (%)	27.13	78.47
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NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	DH-30	DH-30	DH-30	DH-30	DH-30
SAMPLE DATE	11/20/1999	11/20/1999	11/20/1999	11/21/1999	11/21/1999
SAMPLE TIME	14:40	16:00	16:45	10:30	11:00
LAB	EHLAB	EHLAB	EHLAB	EHLAB	EHLAB
LAB NUMBER	99X-05096	99X-05097	99X-05098	99X-05099	99X-05100
REMARKS	DUPLICATE				
TYPE	XRF	XRF	XRF	XRF	XRF
DEPTH	3.5-5.5'	8-10'	10-12'	15-17'	20-22'
SAMPLE NUMBER	IMMS-9910-271D	IMMS-9910-272	IMMS-9910-273	IMMS-9910-274	IMMS-9910-275

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	6523.0	754.0	731.0	160.0	502.0
CADMIUM (CD) TOT	2855.0	1465.0	1081.0	1686.0	610.0
COPPER (CU) TOT	110.0	190.0	89.0	76.0	138.0
IRON (FE) (%) TOT	2.0	3.0	3.0	3.0	4.0
LEAD (PB) TOT	19079.0	127.0	127.0	93.0	31.0
MANGANESE (MN) TOT	426.0	318.0	694.0	2093.0	579.0
ZINC (ZN) TOT	1045.0	1175.0	1281.0	774.0	1675.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

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ANALYSES SUMMARY REPORT

-- SAMPLE TYPE: SOIL --

SITE CODE	UPS	UPS	UPS	UPS	UPS	UPS
SAMPLE DATE	03/16/2001	03/16/2001	03/16/2001	03/16/2001	03/16/2001	03/16/2001
SAMPLE TIME	10:5	10:10	10:15	09:00	09:05	09:10
LAB	RUSTON	RUSTON	RUSTON	RUSTON	RUSTON	RUSTON
LAB NUMBER	01R-00276	01R-00277	01R-00278	01R-00268	01R-00269	01R-00270
REMARKS					DUPLICATE	
DEPTH	4-12"	12-24"	24-36"	0-4"	0-4"	4-12"
SAMPLE NUMBER	UPS-SS02-2	UPS-SS02-3	UPS-SS02-4	UPS-SS03-1	UPS-SS03-1D	UPS-SS03-2

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	140.0	236.0	101.0	33.0	33.0	16.0
CADMIUM (CD) TOT	79.0	179.0	< 10.0	64.0	80.0	24.0
COPPER (CU) TOT	39.0	82.0	27.0	94.0	111.0	43.0
LEAD (PB) TOT	193.0	619.0	26.0	578.0	649.0	261.0
ZINC (ZN) TOT	164.0	394.0	41.0	181.0	225.0	81.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

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ANALYSES SUMMARY REPORT

-- SAMPLE TYPE: SOIL --

SITE CODE	UPS	UPS	UPS	UPS	UPS	UPS
SAMPLE DATE	03/16/2001	03/16/2001	03/16/2001	03/16/2001	03/16/2001	03/16/2001
SAMPLE TIME	09:15	09:20	09:25	09:30	11:00	11:05
LAB	RUSTON	RUSTON	RUSTON	RUSTON	RUSTON	RUSTON
LAB NUMBER	01R-00271	01R-00272	01R-00273	01R-00274	01R-00279	01R-00280
DEPTH	12-22"	22-24"	24-36"	36-48"	0-4"	4-12"
SAMPLE NUMBER	UPS-SS03-3	UPS-SS03-3.1	UPS-SS03-4	UPS-SS03-4.1	UPS-SS04-1	UPS-SS04-2

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	146.0	16.0	391.0	57.0	2297.0	1027.0
CADMIUM (CD) TOT	168.0	< 10.0	71.0	19.0	603.0	370.0
COPPER (CU) TOT	414.0	61.0	1509.0	125.0	6011.0	2065.0
LEAD (PB) TOT	2823.0	424.0	4614.0	753.0	39046.0	15672.0
ZINC (ZN) TOT	815.0	91.0	20337.0	373.0	11096.0	6616.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	UPS	UPS	UPS	UPS	UPS	UPS
SAMPLE DATE	03/16/2001	03/16/2001	03/16/2001	03/16/2001	03/16/2001	03/16/2001
SAMPLE TIME	11:10	11:30	11:35	11:35	11:40	11:45
LAB	RUSTON	RUSTON	RUSTON	TSC-SLC	RUSTON	RUSTON
LAB NUMBER	01R-00281	01R-00291	01R-00292	L011616022	01R-00293	01R-00294
TYPE				SPLP		
DEPTH	12-24"	0-4"	4-8"	4-8"	8-12"	12-24"
SAMPLE NUMBER	UPS-SS04-3	UPS-SS05-1	UPS-SS05-2	UPS-SS05-2	UPS-SS05-2.1	UPS-SS05-3

-- PHYSICAL PARAMETERS --

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-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	1979.0	518.0	275.0	<0.1	1329.0	525.0
CADMIUM (CD) TOT	230.0	320.0	343.0	<0.1	96.0	90.0
COPPER (CU) TOT	1721.0	1100.0	1052.0	<0.1	712.0	742.0
LEAD (PB) TOT	22200.0	8187.0	4482.0	<0.1	7646.0	5158.0
ZINC (ZN) TOT	6864.0	2637.0	1553.0	<0.1	2522.0	1647.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	UPS	UPS	UPS	UPS	UPS	UPS
SAMPLE DATE	03/16/2001	03/16/2001	03/16/2001	03/16/2001	03/16/2001	03/16/2001
SAMPLE TIME	11:50	11:55	13:00	13:05	13:10	13:15
LAB	RUSTON	RUSTON	RUSTON	RUSTON	RUSTON	RUSTON
LAB NUMBER	01R-00295	01R-00296	01R-00297	01R-00298	01R-00299	01R-00300
DEPTH	24-48"	48-72"	0-4"	4-12"	12-24"	24-36"
SAMPLE NUMBER	UPS-SS05-4	UPS-SS05-5	UPS-SS07-1	UPS-SS07-2	UPS-SS07-3	UPS-SS07-4

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	182.0	454.0	986.0	478.0	252.0	212.0
CADMIUM (CD) TOT	69.0	69.0	945.0	483.0	38.0	15.0
COPPER (CU) TOT	408.0	610.0	3643.0	2645.0	2746.0	3522.0
LEAD (PB) TOT	2435.0	6029.0	10425.0	4029.0	910.0	932.0
ZINC (ZN) TOT	876.0	1763.0	6421.0	11465.0	9687.0	12951.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	DH-40	DH-40	DH-40	DH-40	DH-40	DH-40
SAMPLE DATE	11/17/1999	11/17/1999	11/17/1999	11/18/1999	11/18/1999	11/18/1999
SAMPLE TIME	15:40	16:00	16:40	8:30	8:45	9:00
LAB	EHLAB	EHLAB	EHLAB	EHLAB	EHLAB	EHLAB
LAB NUMBER	99X-05111	99X-05112	99X-05113	99X-05114	99X-05115	99X-05116
REMARKS					DUPLICATE	
TYPE	XRF	XRF	XRF	XRF	XRF	XRF
DEPTH	1-2.5'	4-5.5'	5.5-7'	7-8.5'	7-8.5'	8.5-10'
SAMPLE NUMBER	IMMS-9910-251	IMMS-9910-252	IMMS-9910-253	IMMS-9910-254	IMMS-9910-254D	IMMS-9910-255

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	1683.0	47.0	14.0	23.0	19.0	14.0
CADMIUM (CD) TOT	486.0	16.0	< 10.0	< 10.0	< 10.0	< 10.0
COPPER (CU) TOT	2977.0	254.0	51.0	41.0	35.0	54.0
IRON (FE) (t) TOT	3.0	2.0	4.0	4.0	4.0	3.0
LEAD (PB) TOT	14152.0	475.0	72.0	94.0 J4	36.0 J4	32.0 J4
MANGANESE (MN) TOT	1106.0	764.0	1024.0	742.0	705.0	576.0
ZINC (ZN) TOT	5849.0	1034.0	204.0	91.0	84.0	52.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	DH-40	DH-40	DH-40	DH-41	DH-41
SAMPLE DATE	11/18/1999	11/18/1999	11/18/1999	11/09/1999	11/09/1999
SAMPLE TIME	9:15	9:30	9:50	9:00	9:20
LAB	EHLAB	EHLAB	EHLAB	EHLAB	EHLAB
LAB NUMBER	99X-05117	99X-05118	99X-05119	99X-04970	99X-04971
TYPE	XRF	XRF	XRF	XRF	XRF
DEPTH	15-16.5'	20-21.5'	25-27'	0.5-2.0'	2-3.5'
SAMPLE NUMBER	IMMS-9910-256	IMMS-9910-257	IMMS-9910-258	IMMS-9910-232	IMMS-9910-233

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	997.0	98.0	124.0	152.0	J4	374.0	J4
CADMIUM (CD) TOT	80.0	21.0	< 10.0	138.0	J4	165.0	J4
COPPER (CU) TOT	84.0	62.0	75.0	241.0	J4	453.0	J4
IRON (FE) (%) TOT	4.0	3.0	3.0	3.0		3.0	
LEAD (PB) TOT	67.0	J4	27.0	J4	56.0	J4	3103.0
MANGANESE (MN) TOT	804.0	1254.0	844.0	764.0		945.0	
ZINC (ZN) TOT	175.0	118.0	121.0	1014.0	J4	2226.0	J4

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	DH-41	DH-41	DH-41	DH-41	DH-41	DH-41
SAMPLE DATE	11/09/1999	11/09/1999	11/09/1999	11/09/1999	11/09/1999	11/09/1999
SAMPLE TIME	9:30	10:15	11:00	11:05	11:30	12:00
LAB	EHLAB	EHLAB	EHLAB	EHLAB	EHLAB	EHLAB
LAB NUMBER	99X-04972	99X-04973	99X-04974	99X-04975	99X-04976	99X-04977
REMARKS				DUPLICATE		
TYPE	XRF	XRF	XRF	XRF	XRF	XRF
DEPTH	4-5.5'	6-7.5'	8-9.5'	8-9.5'	10-11.5'	15-16.5'
SAMPLE NUMBER	IMMS-9910-234	IMMS-9910-235	IMMS-9910-236	IMMS-9910-236D	IMMS-9910-237	IMMS-9910-238

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	2088.0	J4	895.0	J4	1052.0	J4	736.0	J4	2223.0	J4	1553.0	J4
CADMIUM (CD) TOT	270.0	J4	56.0	J4	113.0	J4	37.0	J4	10.0	J4	< 10.0	UJ4
COPPER (CU) TOT	1420.0	J4	127.0	J4	68.0	J4	40.0	J4	57.0	J4	53.0	J4
IRON (FE) (t) TOT	3.0		2.0		3.0		3.0		4.0		3.0	
LEAD (PB) TOT	5074.0	J4	1809.0	J4	9821.0	J4	3728.0	J4	76.0	J4	57.0	J4
MANGANESE (MN) TOT	597.0		227.0		510.0		506.0		248.0		236.0	
ZINC (ZN) TOT	2365.0	J4	352.0	J4	392.0	J4	196.0	J4	80.0	J4	62.0	J4

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

-- SAMPLE TYPE: SOIL --

	DH-41	DH-42	DH-42	DH-42	DH-42
SITE CODE	DH-41	DH-42	DH-42	DH-42	DH-42
SAMPLE DATE	11/09/1999	11/07/1999	11/07/1999	11/07/1999	11/07/1999
SAMPLE TIME	14:15	13:20	13:20	13:20	13:20
LAB	EHLAB	EHLAB	EHLAB	TSC-SLC	TSC-SLC
LAB NUMBER	99X-04978	99X-04754	99X-04754	L011585009	L011586037
TYPE	XRF	XRF	XRF	SPLP	Seq Ext
DEPTH	20-21.5'	0-2'	0-2'	0-2'	0-2'
OTHER INFO					Water Ext
SAMPLE NUMBER	IMMS-9910-239	IMMS-9910-222	IMMS-9910-222	IMMS-9910-222	IMMS-9910-222

-- PHYSICAL PARAMETERS --

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-- METALS & MINOR CONSTITUENTS --

	846.0 J4	5595.0	5595.0	0.33	0.26
ARSENIC (AS) TOT	846.0 J4	5595.0	5595.0	0.33	0.26
CADMIUM (CD) TOT	16.0 J4	709.0	709.0	0.19	0.21
COPPER (CU) TOT	79.0 J4	1380.0	1380.0	0.01	
IRON (FE) (%) TOT	4.0	2.0	2.0		
LEAD (PB) TOT	33.0 J4	22723.0	22723.0	0.11	
MANGANESE (MN) TOT	366.0	524.0	524.0		
ZINC (ZN) TOT	146.0 J4	3919.0	3919.0	0.42	0.28

-- OTHER PARAMETERS --

MOISTURE CONTENT(%)

16000.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

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-- SAMPLE TYPE: SOIL --

SITE CODE	DH-44	DH-44	DH-44	DH-44	DH-44	DH-44
SAMPLE DATE	11/18/1999	11/18/1999	11/18/1999	11/18/1999	11/19/1999	11/19/1999
SAMPLE TIME	14:30	14:35	15:00	15:30	9:30	10:00
LAB	EHLAB	EHLAB	EHLAB	EHLAB	EHLAB	EHLAB
LAB NUMBER	99X-05120	99X-05121	99X-05084	99X-05085	99X-05086	99X-05087
TYPE	XRF	XRF	XRF	XRF	XRF	XRF
DEPTH	0-1.5'	1.5-3'	4.5-6'	6.0-7.5'	8-9.5'	10-11.5'
SAMPLE NUMBER	IMMS-9910-259	IMMS-9910-260	IMMS-9910-261	IMMS-9910-262	IMMS-9910-263	IMMS-9910-264

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	52.0	1354.0	19.0	18.0	15.0	38.0
CADMIUM (CD) TOT	58.0	300.0	< 10.0	< 10.0	10.0	< 10.0
COPPER (CU) TOT	211.0	1936.0	31.0	37.0	42.0 J4	51.0 J4
IRON (FE) (%) TOT	0.0	2.0	2.0	3.0	3.0	5.0
LEAD (PB) TOT	868.0	11659.0	34.0	95.0	60.0 J4	94.0 J4
MANGANESE (MN) TOT	102.0	618.0	465.0	539.0	593.0	1047.0
ZINC (ZN) TOT	233.0	4076.0	52.0	64.0	80.0	122.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	DH-44	DH-44	DH-44	DH-44	DH-44
SAMPLE DATE	11/19/1999	11/19/1999	11/19/1999	11/19/1999	11/19/1999
SAMPLE TIME	15:00	15:40	17:30	17:35	17:45
LAB	EHLAB	EHLAB	EHLAB	EHLAB	EHLAB
LAB NUMBER	99X-05089	99X-05090	99X-05091	99X-05092	99X-05093
REMARKS				DUPLICATE	
TYPE	XRF	XRF	XRF	XRF	XRF
DEPTH	15-17'	20-21.5'	25-26.5	25-26.5	30-31.5'
SAMPLE NUMBER	IMMS-9910-266	IMMS-9910-267	IMMS-9910-268	IMMS-9910-268D	IMMS-9910-269

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	33.0	250.0	119.0	118.0	21.0
CADMIUM (CD) TOT	< 10.0	82.0	243.0	238.0	< 10.0
COPPER (CU) TOT	101.0 J4	81.0 J4	82.0 J4	57.0 J4	33.0 J4
IRON (FE) (%) TOT	4.0	3.0	3.0	3.0	3.0
LEAD (PB) TOT	103.0 J4	84.0 J4	81.0 J4	27.0 J4	88.0 J4
MANGANESE (MN) TOT	793.0	1587.0	446.0	439.0	853.0
ZINC (ZN) TOT	103.0	426.0	870.0	887.0	154.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	APSD-13	APSD-13	APSD-13	APSD-13	APSD-13	APSD-13
SAMPLE DATE	10/20/1993	10/20/1993	10/20/1993	10/20/1993	10/25/1993	10/25/1993
LAB	EH-LAB	EH-LAB	EH-LAB	EH-LAB	EH-LAB	EH-LAB
LAB NUMBER	93X-2442	93X-2443	93X-2444	93X-2445	93X-2451	93X-2452
DEPTH	0-2'	2-4'	4-6'	6-8'	18-19'	19-21'
SAMPLE NUMBER	APSD-13-1	APSD-13-2	APSD-13-3	APSD-13-4	APSD-13-10	APSD-13-11

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	7433.0	7443.0	7551.0	5952.0	1233.0	1760.0
CADMIUM (CD) TOT	111.0	107.0	130.0	127.0	165.0	176.0
LEAD (PB) TOT	256.0	149.0	197.0	90.0	8053.0	47.0
ZINC (ZN) TOT	251.0	221.0	277.0	190.0	804.0	540.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
R:Rejected.

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-- SAMPLE TYPE: SOIL --

SITE CODE	APSD-13	APSD-13	APSD-13	APSD-13	APSD-13	APSD-13
SAMPLE DATE	10/25/1993	10/25/1993	10/25/1993	10/25/1993	10/25/1993	10/25/1993
LAB	EH-LAB	EH-LAB	EH-LAB	EH-LAB	EH-LAB	EH-LAB
LAB NUMBER	93X-2453	93X-2446	93X-2447	93X-2448	93X-2449	93X-2450
DEPTH	21-23'	8-10'	10-12'	12-14'	14-16'	16-18'
SAMPLE NUMBER	APSD-13-12	APSD-13-5	APSD-13-6	APSD-13-7	APSD-13-8	APSD-13-9

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	945.0	5167.0	5757.0	7194.0	2724.0	2324.0
CADMIUM (CD) TOT	263.0	102.0	81.0	113.0	101.0	172.0
LEAD (PB) TOT	51.0	81.0	77.0	197.0	295.0	298.0
ZINC (ZN) TOT	904.0	210.0	211.0	271.0	334.0	419.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	DH-46	DH-46	DH-47	DH-47	DH-47
SAMPLE DATE	11/23/1999	11/23/1999	11/15/1999	11/15/1999	11/15/1999
SAMPLE TIME	14:30	15:00	10:30	10:45	10:50
LAB	EHLAB	EHLAB	EHLAB	EHLAB	EHLAB
LAB NUMBER	99X-05169	99X-05170	99X-04985	99X-04986	99X-04987
TYPE	XRF	XRF	XRF	XRF	XRF
DEPTH	10.5-12.5'	15-17'	0.5-2.5'	2.5-4.5'	4.5-6.5'
SAMPLE NUMBER	IMMS-9910-287	IMMS-9910-288	IMMS-9910-246	IMMS-9910-247	IMMS-9910-248

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	470.0	153.0	1294.0	4456.0	110.0
CADMIUM (CD) TOT	31.0	< 10.0	298.0	222.0	< 10.0
COPPER (CU) TOT	315.0	88.0	1090.0	1951.0	58.0
IRON (FE) (%) TOT	3.0	3.0	5.0	7.0	3.0
LEAD (PB) TOT	914.0	47.0	5153.0	10372.0	201.0
MANGANESE (MN) TOT	441.0	448.0	555.0	3977.0	595.0
ZINC (ZN) TOT	296.0	123.0	1597.0	15060.0	292.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	DH-47	DH-47	DH-48	DH-48	DH-48
SAMPLE DATE	11/15/1999	11/15/1999	10/10/1999	10/10/1999	10/10/1999
SAMPLE TIME	11:00	13:30	13:40	13:50	14:00
LAB	EHLAB	EHLAB	EHLAB	EHLAB	EHLAB
LAB NUMBER	99X-04988	99X-04989	99X-04256	99X-04257	99X-04258
TYPE	XRF	XRF	XRF	XRF	XRF
DEPTH	6.5-8.5'	15-15.5'	0-2'	2-4'	4-6'
SAMPLE NUMBER	IMMS-9910-249	IMMS-9910-250	IMMS-9910-131	IMMS-9910-132	IMMS-9910-133

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	202.0	306.0	906.0	33.0	12.0
CADMIUM (CD) TOT	< 10.0	< 10.0	434.0	< 10.0	< 10.0
COPPER (CU) TOT	78.0	426.0	1183.0	37.0	23.0
IRON (FE) (%) TOT	3.0	6.0	4.0	2.0	2.0
LEAD (PB) TOT	463.0	3829.0	6294.0	94.0	21.0
MANGANESE (MN) TOT	756.0	4587.0	958.0	507.0	459.0
ZINC (ZN) TOT	763.0	13667.0	4954.0	112.0	69.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	DH-59	DH-59	DH-59	DH-59	DH-59	DH-59
SAMPLE DATE	05/23/2001	05/23/2001	05/23/2001	05/23/2001	05/23/2001	05/23/2001
SAMPLE TIME	14:50	14:50	14:50	14:50	14:50	14:50
LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
LAB NUMBER	L010788001	L011585003	L011586013	L011586014	L011586015	L011586016
TYPE		SPLP	Seq Ext	Seq Ext	Seq Ext	Seq Ext
DEPTH	0-2'	0-2'	0-2'	0-2'	0-2'	0-2'
OTHER INFO			Water Ext	NH4Ac Ext	HONH2 HCl Ext	H2O2 Ext
SAMPLE NUMBER	DH-59-1	DH-59-1	DH-59-1	DH-59-1	DH-59-1	DH-59-1

-- PHYSICAL PARAMETERS --

PH	7.7
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-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	4567.0	0.006	0.069	2.2	0.064	0.26
BERYLLIUM (BE) TOT	<2.0					
CADMIUM (CD) TOT	400.0	0.91	0.76	2.6	0.22	0.85
COPPER (CU) TOT	12726.0	0.067				
IRON (FE) (%) TOT	6.8					
LEAD (PB) TOT	104528.0	0.36				
MANGANESE (MN) TOT	1430.0					
MERCURY (HG) TOT	90.0 J4					
SELENIUM (SE) TOT	60.0					
SILVER (AG) TOT	359.0					
THALLIUM (TL) TOT	117.0					
ZINC (ZN) TOT	16516.0 J2	6.1	4.9	43.0	6.2	37.0

-- OTHER PARAMETERS --

MOISTURE CONTENT(%)	109000.0
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NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	DH-59	DH-59	DH-59	DH-59	DH-59	DH-59
SAMPLE DATE	05/23/2001	05/23/2001	05/23/2001	05/23/2001	05/23/2001	05/23/2001
SAMPLE TIME	14:50	14:50	14:55	15:30	16:15	16:30
LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
LAB NUMBER	L011586017	L011586018	L010788002	L010788003	L010788004	L010788005
TYPE	Seq Ext	Seq Ext				
DEPTH	0-2'	0-2'	2-4'	4-6'	8-10'	10-12'
OTHER INFO	N2H5Cl Ext	Residue				
SAMPLE NUMBER	DH-59-1	DH-59-1	DH-59-2	DH-59-3	DH-59-5	DH-59-6

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	9.7	97.0	1476.0	28.0	47.0	1322.0
BERYLLIUM (BE) TOT			<2.0	<2.0	<2.0	<2.0
CADMIUM (CD) TOT	0.13	4.1	423.0	37.0	64.0	47.0
COPPER (CU) TOT			8368.0	588.0	575.0	197.0
IRON (FE) (%) TOT			4.6	2.9	3.3	3.3
LEAD (PB) TOT			65288.0	222.0	309.0	172.0
MANGANESE (MN) TOT			1121.0	606.0	1682.0	987.0
MERCURY (HG) TOT			60.0 J4	0.25 J4	0.15 J4	1.0 J4
SELENIUM (SE) TOT			20.0	<10.0	<10.0	<10.0
SILVER (AG) TOT			246.0	<10.0	<10.0	<10.0
THALLIUM (TL) TOT			43.0	23.0	52.0	25.0
ZINC (ZN) TOT	14.0	170.0	15109.0 J2	401.0 J2	624.0 J2	387.0 J2

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	DH-59	DH-59	DH-59	DH-59	DH-59	DH-59
SAMPLE DATE	05/23/2001	05/23/2001	05/23/2001	05/23/2001	05/23/2001	05/23/2001
SAMPLE TIME	17:55	17:55	17:55	17:55	17:55	17:55
LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
LAB NUMBER	L010788006	L011586001	L011586002	L011586003	L011586004	L011586005
TYPE		Seq Ext	Seq Ext	Seq Ext	Seq Ext	Seq Ext
DEPTH	15-17'	15-17'	15-17'	15-17'	15-17'	15-17'
OTHER INFO		Water Ext	NH4Ac Ext	HONH2 HCl Ext	H2O2 Ext	N2H5Cl Ext
SAMPLE NUMBER	DH-59-7	DH-59-7	DH-59-7	DH-59-7	DH-59-7	DH-59-7

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	13.0	0.72	5.5	1.6	2.2	9.3
BERYLLIUM (BE) TOT	<2.0					
CADMIUM (CD) TOT	10.0	0.016	0.12	0.03	0.029	0.011
COPPER (CU) TOT	34.0					
IRON (FE) (%) TOT	1.3					
LEAD (PB) TOT	93.0					
MANGANESE (MN) TOT	117.0					
MERCURY (HG) TOT	0.26 J4					
SELENIUM (SE) TOT	<10.0					
SILVER (AG) TOT	<10.0					
THALLIUM (TL) TOT	25.0					
ZINC (ZN) TOT	99.0 J2	0.078	0.69	0.15	0.23	0.18

-- OTHER PARAMETERS --

MOISTURE CONTENT (%)	112000.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	DH-59	DH-59	DH-59	DH-59	DH-59	DH-59
SAMPLE DATE	05/23/2001	05/23/2001	05/23/2001	05/23/2001	05/23/2001	05/23/2001
SAMPLE TIME	17:55	17:55	17:55	17:55	17:55	18:15
LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
LAB NUMBER	L011586006	L011603001	L011603005	L011603008	L011603012	L010788007
TYPE	Seq Ext	Seq SPLP	Seq SPLP	Seq SPLP	Seq SPLP	
DEPTH	15-17'	15-17'	15-17'	15-17'	15-17'	20-22'
OTHER INFO	Residue	Leach #1	Leach #5	Leach #8	Leach #12	
SAMPLE NUMBER	DH-59-7	DH-59-7	DH-59-7	DH-59-7	DH-59-7	DH-59-8

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	7.5	1.5	0.86	0.42	0.36	224.0
BERYLLIUM (BE) TOT						<2.0
CADMIUM (CD) TOT	0.022	0.013	0.002	0.002	0.001	324.0
COPPER (CU) TOT						76.0
IRON (FE) (%) TOT						2.2
LEAD (PB) TOT						148.0
MANGANESE (MN) TOT						185.0
MERCURY (HG) TOT						5.0 J4
SELENIUM (SE) TOT						<10.0
SILVER (AG) TOT						<10.0
THALLIUM (TL) TOT						30.0
ZINC (ZN) TOT	1.8	0.1	0.17	0.17	0.054	172.0 J2

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

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-- SAMPLE TYPE: SOIL --

SITE CODE	DH-59	DH-59	DH-60	DH-60	DH-60
SAMPLE DATE	05/23/2001	05/23/2001	05/12/2001	05/12/2001	05/12/2001
SAMPLE TIME	18:20	18:50	10:55	18:25	19:05
LAB	TSC-SLC	TSC-SLC	RUSTON	RUSTON	RUSTON
LAB NUMBER	L010788008	L010788009	01R-01409	01R-01419	01R-01420
REMARKS	DUPLICATE				
DEPTH	20-22'	25-27'	0-2'	30-32'	35-37'
SAMPLE NUMBER	DH-59-8D	DH-59-9	DH-60-1	DH-60-10	DH-60-11

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	207.0	169.0	180.0	< 10.0	13.0
BERYLLIUM (BE) TOT	<2.0	<2.0			
CADMIUM (CD) TOT	336.0	60.0	643.0	< 10.0	< 10.0
COPPER (CU) TOT	82.0	67.0	718.0	31.0	27.0
IRON (FE) (¶) TOT	1.8	2.5	3.0	1.0	4.0
LEAD (PB) TOT	172.0	262.0	2819.0	58.0	62.0
MANGANESE (MN) TOT	168.0	218.0	489.0	426.0	559.0
MERCURY (HG) TOT	2.8 J4	0.11 J4			
SELENIUM (SE) TOT	<10.0	<10.0			
SILVER (AG) TOT	<10.0	<10.0			
THALLIUM (TL) TOT	27.0	16.0			
ZINC (ZN) TOT	178.0 J2	159.0 J2	1699.0	83.0	120.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	DH-22-1	DH-22-2	DH-22-3
SAMPLE DATE	04/27/1987	04/02/1987	04/27/1987
LAB	TSC-SLC	TSC-SLC	TSC-SLC
LAB NUMBER	87-4472	87-4473	87-4474
DEPTH	0-1.5'	2-3.5'	4-5.5'
SAMPLE NUMBER	HYD-8036	HYD-8035	HYD-8037

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	125.0	450.0	150.0
CADMIUM (CD) TOT	425.0	135.0	48.0
COPPER (CU) TOT	900.0	1400.0	650.0
IRON (FE) TOT	5000.0	17500.0	12500.0
LEAD (PB) TOT	8500.0	7750.0	3100.0
MANGANESE (MN) TOT	225.0	600.0	380.0
ZINC (ZN) TOT	2400.0	3200.0	1150.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	DH-22-4	DH-22-5	DH-22-6	DH-22-6
SAMPLE DATE	04/27/1987	04/27/1987	04/27/1987	04/27/1987
LAB	TSC-SLC	TSC-SLC	TSC-SLC	VERSR
LAB NUMBER	87-4475	87-4476	87-4477	
REMARKS				SPLIT
DEPTH	6-7.5'	8-9.5'	10-11.5'	10-11.5'
SAMPLE NUMBER	HYD-8038	HYD-8039	HYD-8040	HYD-8046.A14

-- MAJOR CONSTITUENTS --

MAGNESIUM (MG) DIS		1940.0
SODIUM (NA) DIS		188.0
POTASSIUM (K) DIS		1310.0

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	400.0	10.0	11.0	
CADMIUM (CD) TOT	240.0	1.0	1.5	
COPPER (CU) TOT	1650.0	22.0	31.0	16.0
IRON (FE) TOT	18000.0	55000.0	37000.0	13200.0
LEAD (PB) TOT	20750.0	46.0	27.0	26.0
MANGANESE (MN) TOT	750.0	245.0	285.0	251.0
MERCURY (HG) TOT				0.1
NICKEL (NI) TOT				6.7
ZINC (ZN) TOT	1400.0	48.0	38.0	

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	DH-22-7	DH-22-9	DH-22-10
SAMPLE DATE	04/27/1987	04/27/1987	04/27/1987
LAB	TSC-SLC	TSC-SLC	TSC-SLC
LAB NUMBER	87-4478	87-4479	87-4480
DEPTH	15-16.5'	25-26'	30-31.5'
SAMPLE NUMBER	HYD-8041	HYD-8042	HYD-8043

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	40.0	450.0	250.0
CADMIUM (CD) TOT	1.5	55.0	65.0
COPPER (CU) TOT	52.0	63.0	165.0
IRON (FE) TOT	30500.0	18000.0	62500.0
LEAD (PB) TOT	40.0	25.0	105.0
MANGANESE (MN) TOT	290.0	180.0	1050.0
ZINC (ZN) TOT	77.0	115.0	220.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	DH-22-11	DH-22-11	DH-23-1	DH-23-2
SAMPLE DATE	04/27/1987	04/27/1987	04/28/1987	04/28/1987
LAB	TSC-SLC	VERSR	TSC-SLC	TSC-SLC
LAB NUMBER	87-4481		87-4482	87-4483
REMARKS		SPLIT		
DEPTH	35-36.5'	35-36.5'	0-1.5'	2-3.5'
SAMPLE NUMBER	HYD-8044	HYD-8045.A14	HYD-8047	HYD-8048

-- MAJOR CONSTITUENTS --

MAGNESIUM (MG) DIS	4140.0
SODIUM (NA) DIS	218.0
POTASSIUM (K) DIS	1210.0

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	18.0	73.0	92.0
CADMIUM (CD) TOT	2.0	15.0	11.0
COPPER (CU) TOT	13.0	79.0	1300.0
IRON (FE) TOT	8500.0	36400.0	190000.0
LEAD (PB) TOT	69.0	62.0	9750.0
MANGANESE (MN) TOT	290.0	423.0	19750.0
MERCURY (HG) TOT		0.15	
NICKEL (NI) TOT		12.0	
ZINC (ZN) TOT	67.0	10000.0	52000.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

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-- SAMPLE TYPE: SOIL --

SITE CODE	DH-22-11	DH-22-11	DH-23-1	DH-23-2
SAMPLE DATE	04/27/1987	04/27/1987	04/28/1987	04/28/1987
LAB	TSC-SLC	VERSR	TSC-SLC	TSC-SLC
LAB NUMBER	87-4481		87-4482	87-4483
REMARKS		SPLIT		
DEPTH	35-36.5'	35-36.5'	0-1.5'	2-3.5'
SAMPLE NUMBER	HYD-8044	HYD-8045.A14	HYD-8047	HYD-8048

-- MAJOR CONSTITUENTS --

MAGNESIUM (MG) DIS	4140.0
SODIUM (NA) DIS	218.0
POTASSIUM (K) DIS	1210.0

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	18.0	73.0	92.0
CADMIUM (CD) TOT	2.0	15.0	11.0
COPPER (CU) TOT	13.0	79.0	1300.0
IRON (FE) TOT	8500.0	36400.0	28000.0
LEAD (PB) TOT	69.0	62.0	1750.0
MANGANESE (MN) TOT	290.0	423.0	2850.0
MERCURY (HG) TOT		0.15	
NICKEL (NI) TOT		12.0	
ZINC (ZN) TOT	67.0	10000.0	52000.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	DH-23-3	DH-23-3	DH-23-4	DH-23-6
SAMPLE DATE	04/28/1987	04/28/1987	04/28/1987	04/28/1987
LAB	TSC-SLC	VERSR	TSC-SLC	TSC-SLC
LAB NUMBER	87-4456		87-4457	87-4459
REMARKS		SPLIT		
DEPTH	4-5.5'	4-5.5'	6-7.5'	15-16'
SAMPLE NUMBER	HYD-8049	HYD-8053.A14	HYD-8050	HYD-8051

-- MAJOR CONSTITUENTS --

MAGNESIUM (MG) DIS	5590.0
SODIUM (NA) DIS	383.0
POTASSIUM (K) DIS	2590.0

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	125.0	175.0	700.0
CADMIUM (CD) TOT	23.0	22.0	150.0
COPPER (CU) TOT	2350.0	1630.0	3100.0
IRON (FE) TOT	120000.0	14800.0	137500.0
LEAD (PB) TOT	10750.0	12800.0	12750.0
MANGANESE (MN) TOT	10500.0	11900.0	14500.0
MERCURY (HG) TOT		0.19	
NICKEL (NI) TOT		7.2	
ZINC (ZN) TOT	3950.0	44000.0	44000.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	DH-23-6	DH-23-7	DH-24-1
SAMPLE DATE	04/28/1987	04/28/1987	04/30/1987
LAB	VERSR	TSC-SLC	TSC-SLC
LAB NUMBER		87-4458	87-4449
REMARKS	SPLIT		
DEPTH	15-16'	20-21.5'	0-1.5'
SAMPLE NUMBER	HYD-8054.A14	HYD-8052	HYD-8055

-- MAJOR CONSTITUENTS --

MAGNESIUM (MG) DIS	2680.0
SODIUM (NA) DIS	306.0
POTASSIUM (K) DIS	2610.0

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	9000.0	39.0
CADMIUM (CD) TOT	34.0	0.75
COPPER (CU) TOT	3280.0	5600.0
IRON (FE) TOT	13900.0	122500.0
LEAD (PB) TOT	34500.0	22250.0
MANGANESE (MN) TOT	14700.0	16250.0
MERCURY (HG) TOT	5.4	
NICKEL (NI) TOT	29.0	
ZINC (ZN) TOT	38000.0	290.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	DH-42	DH-43	DH-43	DH-43	DH-43
SAMPLE DATE	11/08/1999	11/15/1999	11/15/1999	11/15/1999	11/15/1999
SAMPLE TIME	14:40	14:10	14:30	15:00	15:15
LAB	EHLAB	EHLAB	EHLAB	EHLAB	EHLAB
LAB NUMBER	99X-04969	99X-04990	99X-04991	99X-04992	99X-04993
TYPE	XRF	XRF	XRF	XRF	XRF
DEPTH	30-31.5'	0.5-2'	2-4'	6-8'	8-10'
SAMPLE NUMBER	IMMS-9910-231	IMMS-9910-300	IMMS-9910-301	IMMS-9910-302	IMMS-9910-303

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	267.0	44.0	84.0	11.0	14.0
CADMIUM (CD) TOT	76.0	10.0	16.0	< 10.0	< 10.0
COPPER (CU) TOT	53.0	201.0	280.0	28.0	28.0
IRON (FE) (%) TOT	4.0	3.0	3.0	2.0	2.0
LEAD (PB) TOT	65.0	330.0	593.0	18.0	25.0
MANGANESE (MN) TOT	462.0	579.0	576.0	432.0	297.0
ZINC (ZN) TOT	559.0	148.0	280.0	55.0	41.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	DH-43	DH-43	DH-43	DH-43	DH-43	DH-43
SAMPLE DATE	11/15/1999	11/15/1999	11/15/1999	11/15/1999	11/16/1999	11/16/1999
SAMPLE TIME	15:40	16:20	18:00	18:25	9:00	10:15
LAB	EHLAB	EHLAB	EHLAB	EHLAB	EHLAB	EHLAB
LAB NUMBER	99X-04994	99X-04995	99X-04996	99X-04997	99X-04998	99X-04999
TYPE	XRF	XRF	XRF	XRF	XRF	XRF
DEPTH	10-12'	19-21'	25-26.5'	30-31.5'	35-37'	40-41'
SAMPLE NUMBER	IMMS-9910-304	IMMS-9910-305	IMMS-9910-306	IMMS-9910-307	IMMS-9910-308	IMMS-9910-309

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	24.0	15.0	41.0	231.0	384.0	98.0
CADMIUM (CD) TOT	< 10.0	< 10.0	13.0	55.0	114.0	104.0
COPPER (CU) TOT	41.0	61.0	66.0	57.0	74.0	50.0
IRON (FE) (%) TOT	4.0	3.0	3.0	2.0	3.0	2.0
LEAD (PB) TOT	21.0	28.0	38.0	22.0	28.0	30.0
MANGANESE (MN) TOT	502.0	557.0	747.0	437.0	430.0	323.0
ZINC (ZN) TOT	51.0	53.0	82.0	188.0	345.0	402.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	EH-57-1	EH-57-2	EH-57-3
SAMPLE DATE	05/04/1987	05/04/1987	05/04/1987
LAB	TSC-SLC	TSC-SLC	TSC-SLC
LAB NUMBER	87-4487	87-4486	87-4488
DEPTH	0-1.5'	2-3.5'	4-5.5'
SAMPLE NUMBER	HYD-8198	HYD-8199	HYD-8200

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	67.0	16.0	15.0
CADMIUM (CD) TOT	10.0	1.0	0.75
COPPER (CU) TOT	39.0	25.0	24.0
IRON (FE) TOT	23000.0	15500.0	14000.0
LEAD (PB) TOT	185.0	11.0	9.0
MANGANESE (MN) TOT	600.0	245.0	250.0
ZINC (ZN) TOT	275.0	43.0	53.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	EH-57-4	EH-57-5	EH-57-6
SAMPLE DATE	05/04/1987	05/04/1987	05/04/1987
LAB	TSC-SLC	TSC-SLC	TSC-SLC
LAB NUMBER	87-4484	87-4490	87-4493
DEPTH	6-7.5'	8-9.5'	10-11.5'
SAMPLE NUMBER	HYD-8201	HYD-8202	HYD-8203

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	18.0	14.0	10.0
CADMIUM (CD) TOT	1.0	1.5	1.5
COPPER (CU) TOT	29.0	40.0	30.0
IRON (FE) TOT	30500.0	30500.0	26500.0
LEAD (PB) TOT	21.0	16.0	18.0
MANGANESE (MN) TOT	395.0	325.0	270.0
ZINC (ZN) TOT	95.0	53.0	53.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	EH-57-7	EH-57-8	EH-57-10
SAMPLE DATE	05/04/1987	05/04/1987	05/04/1987
LAB	TSC-SLC	TSC-SLC	TSC-SLC
LAB NUMBER	87-4485	87-4489	87-4491
DEPTH	15-16.5'	20-21.5'	30-31'
SAMPLE NUMBER	HYD-8204	HYD-8205	HYD-8206

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	22.0	19.0	15.0
CADMIUM (CD) TOT	0.5	2.5	2.0
COPPER (CU) TOT	63.0	68.0	56.0
IRON (FE) TOT	24000.0	30000.0	36500.0
LEAD (PB) TOT	25.0	16.0	12.0
MANGANESE (MN) TOT	1050.0	1050.0	650.0
ZINC (ZN) TOT	72.0	72.0	57.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
R:Rejected.

APPENDIX B

STANDARD OPERATING PROCEDURES (SOP) FOR SURFACE SOIL AND SUB-SURFACE SOIL SAMPLE COLLECTION

**STANDARD OPERATING PROCEDURE
DETERMINATION, IDENTIFICATION, AND DESCRIPTION OF
FIELD SAMPLING SITES[©]
HF-SOP-2**

1.0 PURPOSE

This Standard Operating Procedure (SOP) is to be used for locating, identifying and describing field sampling sites. The objective of this SOP is to clearly identify the sampling site location and to describe the site in such a manner as to ensure accurate site relocation for repetitive sampling.

2.0 EQUIPMENT

- Accurate map or air photo with coordinate grid
- Global Positioning System (GPS) instrument
- Colored site marker (a steel fence post, rebar, wooden stake, etc.)
- Identification tag
- Camera and film
- Detailed map

3.0 PROCEDURE

Location of field sampling sites can be reported using the following:

- Latitude-Longitude - accurate to at least 0.2 minutes and preferably to less than 0.1 minutes
- General Land Office Coordinates - see **Figure 1** (System for Geographical Location of Features) for location procedure. Location should be at least to nearest quarter-quarter section.
- State or Project Coordinates - Many project sites have a plane coordinate grid and many states have a coordinate system. Location should be as accurate as possible.
- Narrative Description - In addition to a location by latitude-longitude, coordinates, or general land office designation or coordinates, a narrative description also is valuable. Some sampling sites are so close together that they cannot be separated except by a narrative description. Such locations should be referenced by distance and azimuth from some "permanent" fixtures (large rocks), trees, buildings, etc. Additionally, an air photo or ordinary color photograph (with the site clearly marked) is very helpful in locating sites.

All field sampling sites will be identified by placement of colored site markers such as a steel fence post, rebar, wooden stake, etc. The station designation and location will be noted on an identification tag that is securely fastened to the site marker. The station designation used will be determined by the Project Manager.

For each field sampling site established, an Identification and Description of Sampling Site form (**HF-FORM-407**) will be completed. All information requested on the form will be supplied. In addition, a photograph of the site with a full description of the "view" of the photo noted (e.g. "looking downstream from bedrock outcrop 50 feet upstream of site") will be attached or mounted on the form. The sampling site will be marked on the photo and on a detailed site map.

4.0 RELATED REFERENCES

HF-FORM-407 - Identification and Description of Field Sampling Sites

SYSTEM FOR GEOGRAPHICAL LOCATION OF FEATURES

Geographic features such as sampling sites, wells and springs are assigned a location number based on the system of land subdivision used by the U.S. Bureau of Land Management. The number consists of 10 to 16 characters and describes the location by township, range, section and position within the section. The figure below illustrates this numbering method. The first three or four characters of the number give the township, the next three or four the range. The next two numbers give the section number within the township and the next letters describe the location within the quarter section (160-acre tract) and quarter-quarter section (40-acre tract). If the location is known to sufficient accuracy then one or two additional letters can be used to describe the quarter-quarter-quarter-quarter section (2 1/2-acre tract). These subdivisions of the 640-acre section are designated as A, B, C and D in a counterclockwise direction beginning in the northeast quadrant. If there is more than one feature in a tract, consecutive digits beginning with the number 1 are added to the number. For example, if a sampling site was in Section 21, Township 29 North, Range 20 West, it would be numbered 29N20W21DAAD2. The letters DAAD indicate the well is in the southeast 1/4 of the northeast 1/4 of the northeast 1/4 of the southeast 1/4 and the number 2 following the letters DAAD indicates there is more than one site location in this 2 1/2-acre tract. If geographic features are located to the nearest 40 acre or 10 acre tract, the numbering methodology is the same except the last one or two letters are absent.

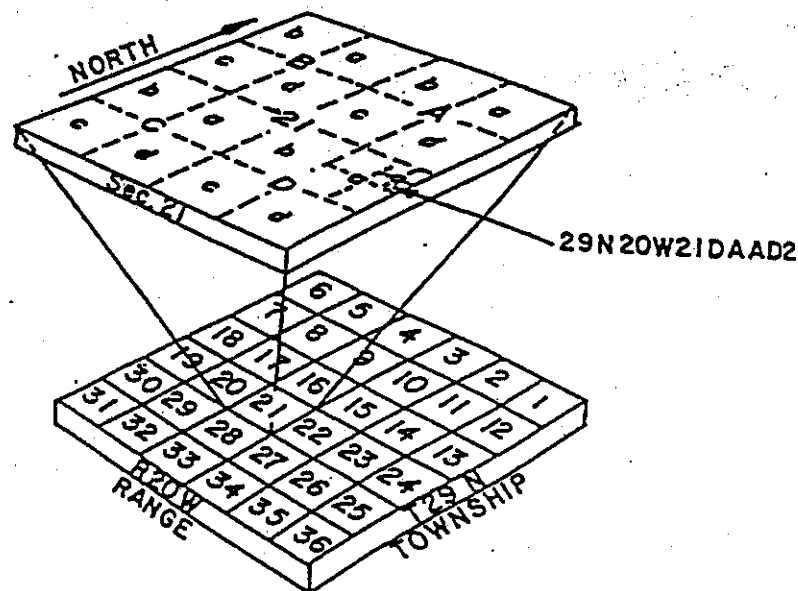


Figure 1. System for Geographical Location of Features

STANDARD OPERATING PROCEDURE FORM

IDENTIFICATION AND DESCRIPTION OF FIELD SAMPLING SITES[®]
HF-FORM-407

PROJECT: _____ NUMBER: _____

SITE CODE: _____ HYDROMETRICS'
UNIQUE SITE CODE: _____NARRATIVE SITE DESCRIPTION: _____

SITE LOCATION: T _____ N S R _____ E W SEC _____ TRACT _____

LATITUDE/LONGITUDE _____ N _____ E

COORDINATES: _____

COUNTY: _____ STATE: _____

STATION TYPE: Stream Spring Well Pond Process Water Soil
OTHER: _____REMARKS (Access, etc.): _____

(ATTACH PHOTO HERE)

DESCRIPTION OF PHOTO "VIEW": _____

DATE: _____ INDIVIDUAL (Signature): _____

ATTACH MAP OF SAMPLING SITE TO THIS FORM

STANDARD OPERATING PROCEDURE

PACKING AND SHIPPING SAMPLES HF-SOP-4

1.0 PURPOSE

This procedure is to be followed when packing and shipping water or soil samples to the laboratory by commercial carrier. The Chain-of-Custody standard operating procedure (HF-SOP-5) also must be followed if required in the project plan.

2.0 PROCEDURE

- 2.1 All samples must be labeled and labels filled out in waterproof ink. The label can be Hydrometrics' standard shipping label or may be a project-specific label. Sample labeling procedures are detailed in **HF-SOP-29** (Labeling and Documentation of Samples).
- 2.2 All samples are placed in the shipping container - normally a metal or plastic cooler.
- 2.3 Packing:
 - 2.3.1 Sample containers are typically placed in a cooler. Other commercially available insulated containers may be used. The project manager should determine that the containers are appropriate to the type of sample being shipped.
 - 2.3.2 If trip blanks are required, typical for organics sampling, be sure one is present for each and every shipping container.
 - 2.3.3 If an ice pack is used, place the ice pack in the cooler or cooler lid as needed. Fill space with bubble mat wrap or packing material. If necessary, place bubble wrap on top of samples. Sufficient packing material should be used to prevent sample containers from contacting each other during transport.
 - 2.3.4 If custody seals are required, they will be placed on at least two places connecting the cooler container lid to the cooler.
 - 2.3.5 Coolers are then wrapped with nylon strapping tape. Two full rotations of tape will be placed at least two places on the cooler.
- 2.4 Packing and shipping procedures for Superfund facilities should follow guidelines outlined in the EPA document "A Compendium of Superfund Field Operating Methods".

3.0 SHIPPING

Samples can be sent by commercial air carrier, overnight express, Federal Express or other means. The allowable holding time and often the ability to keep samples cold are important considerations. Copies of all shipment records must be kept in the project files.

Each sample container will be marked with:

- Sampling organization name, address and telephone number;
- Laboratory name, address and telephone number; and
- Ship samples via courier following any applicable DOT requirements. The project manager should determine if there are any special shipping considerations.

3.1 Documents

Each shipping container will contain a description of samples enclosed, date of collection and date of shipment, either a cover letter or a Request for Analytical Services, and/or a Chain-of-Custody form. See Labeling and Documentation of Samples (**HF-SOP-29**).

For Chain-of-Custody shipments complete a Chain-of-Custody form (see Chain-of-Custody Standard Operating Procedure **HF-SOP-5**).

- Sign the form.
- Place two copies in zip-lock bag in sample container.
- Keep one signed copy in project file.

Signing of the Chain-of-Custody form (record) relinquishes custody of the samples. Relinquishing custody should only occur when directly shipping to the analytical laboratory.

4.0 RELATED REFERENCES

HF-SOP-5 Chain-of Custody Procedure

HF-SOP-29 Labeling and Documentation of Samples

U.S. EPA, 1982. Handbook for Sampling and Sample Preservation of Water and Wastewater. EPA-600/4-82-029.

U.S. EPA, 1987. A Compendium of Superfund Field Operations Methods PB88-181557.

STANDARD OPERATING PROCEDURE

CHAIN-OF CUSTODY HF-SOP-5

1.0 PURPOSE

The purpose of this procedure is to maintain a chain-of-custody for samples. All soil and water samples collected and sent to the laboratory for analysis will be documented using standard chain-of-custody procedures.

2.0 CUSTODY PROCEDURE

Samples will be collected at established project sampling sites using Standard Operating Procedures (SOP). Sampling activities will be recorded in the samplers daily log book and the appropriate collection form(s) completed (see appropriate sampling SOP). Each sample container will be identified by labeling. Labels are attached to sample bottles and are protected with clear label tape to prevent abrasion of labeling information and to guard against failure of label adhesive.

2.1 Sample Identification

Each sample bottle should be labeled with the following information:

- Site;
- Sample Number;
- Person taking the sample;
- Date and time of collection;
- Sample matrix (water, soil, oil, etc.);
- Basis (total or dissolved);
- Preservation; and
- Analyses to be performed.

Labels will be written in waterproof ink.

Use of pre-printed, self-adhesive labels, if available, is preferred.

All samples must be traceable from the time the samples are collected until they are received by the analytical laboratory. The laboratory is then responsible for custody during processing and analysis.

A sample is under custody if:

- It is in your possession;
- It is in your view, after being in your possession;
- It was in your possession and then you locked it up to prevent tampering; or
- It was in your possession and then you placed it in a designated secure area.

2.2 Custody Records

Each sample is identified on a Chain-of-Custody Form(s) (**HF-FORM-001**) by its sample number, date and time of collection, and analysis requested.

Documents will consist of:

- Sample collection records;
- Chain-of-Custody form(s) (**HF-FORM-001**);
- Analytical Parameter List(s) including analytical methods and detection limits if not on the Chain-of-Custody form;
- Shipping receipt(s); and
- Purchase Order(s).

3.0 CUSTODY TRANSFER AND SHIPMENT

All samples will be accompanied by **Chain - of - Custody** record (**HF-FORM-001**). The following procedures will be followed:

- When transferring the possession of samples, the individual(s) relinquishing and receiving will sign, date and note the time on the record. This record documents sample custody transfer from the sampler to the laboratory.

- Samples will be packaged properly for shipment and dispatched to the appropriate laboratory for analysis, with a separate custody record accompanying each shipment. Shipping containers will be sealed for shipment to the laboratory. The method of shipment, courier name(s) and other pertinent information are entered in the "Remarks" box.
- All shipments will be accompanied by the **Chain - of - Custody Record (HF-FORM-001)** identifying its contents. The original record will accompany the shipment and a copy will be retained in the project file.
- Analytical parameters requested must be noted on the Chain-of-Custody Record, or an attached analytical parameters list accompanying the Chain-of-Custody Record. If not attached to the Chain-of-Custody, an Analytical Parameter List including analytical methods and detection limits must be included with each shipment and should specify methods of analysis required for each parameter.
- All shipping receipts (next day air waybills, freight bills, post office receipts, bills of lading, etc.) purchase orders, and sample collection records will be retained in the project file.


4.0 CUSTODY SEALS

When samples are shipped to the laboratory, they must be placed in containers sealed with custody seals. A typical custody seal is shown in **Figure 1**. Some custody seals are serially numbered. Other custody seals are unnumbered seals or evidence tape.

Two seals must be placed on each shipping container (cooler), one at the front and one at the back as shown in **Figure 1**. Clear tape should be placed over seals to ensure that seals are not accidentally broken during shipment.

5.0 RELATED REFERENCES

HF-FORM-001 - Chain-of-Custody Record (3-part NCR form)

 UNITED STATES ENVIRONMENTAL PROTECTION AGENCY OFFICIAL SAMPLE SEAL	SAMPLE NO.	DATE	SEAL BROKEN BY DATE EPA FORM 7600-2 (R7-78)
	SIGNATURE		
	PRINT NAME AND TITLE (Inspector, Analyst or Technician)		

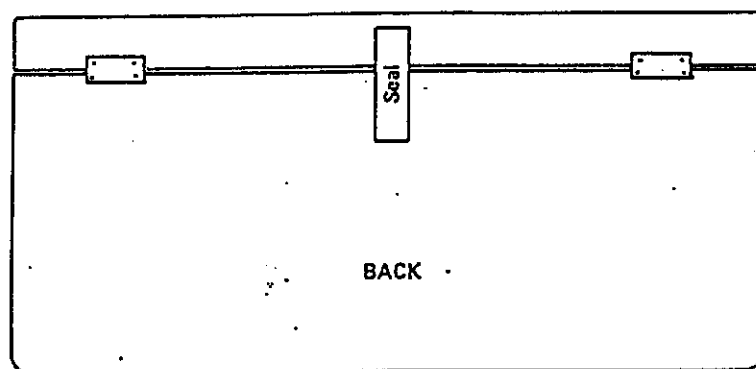
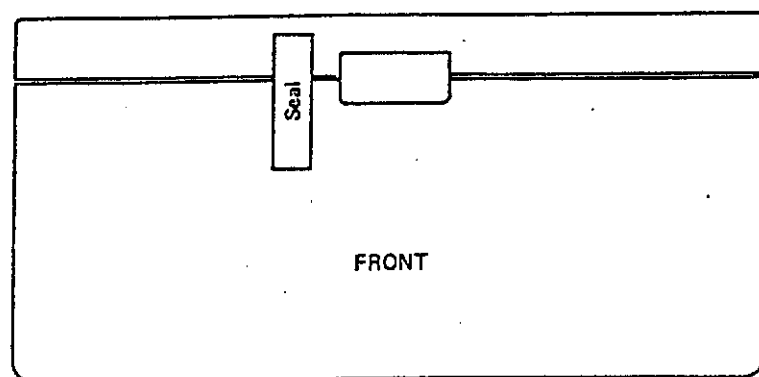


Figure 1. Proper Placement of Custody Seals

CHAIN OF CUSTODY RECORD

[illegible]

STANDARD OPERATING PROCEDURE

DECONTAMINATION OF SAMPLING EQUIPMENT HF-SOP-7

1.0 PURPOSE

Unless entirely disposable sampling equipment is used, cross-contamination can occur and sampling equipment must be decontaminated between sampling locations. The following are examples of equipment that may require decontamination:

1. Water level probe;
2. Reusable bailers used to obtain samples from wells;
3. Containers used to composite or contain samples;
4. Soil piston sampler;
5. Water filter apparatus (0.45 micron);
6. Soil coring devices; and
7. Drilling rig and/or backhoe.

This list is not exhaustive and field personnel should review sampling plans prior to implementation, and plan decontamination procedures in accordance with the type of work to be conducted and the equipment to be used.

2.0 EQUIPMENT

One or more of the items below is required. Check procedures that follow.

Tap water	Gloves (latex or nitrile)	
Non-phosphate detergent	Distilled or Deionized (DI) Water	Buckets
High Pressure Washer	Organic solvent (preferably hexane or methanol), certified ACS Grade or better	Brushes

3.0 PROCEDURES

Effective decontamination of sampling equipment for sampling inorganics can be achieved by using the following three step process:

1. Wash equipment in warm water and detergent, scrubbing with brushes as necessary to remove visible contaminants;
2. Rinse equipment thoroughly with clean tap water; and

3. Rinse equipment thoroughly with DI (deionized) water.

When sampling for various organic parameters which leave heavy residues on sampling equipment, decontamination may require additional steps:

4. Solvent rinse (preferably hexane or methanol, certified ACS Grade or better); and
5. DI water rinse.

Deionized or distilled water used during sampling equipment decontamination should be obtained from a source with documented capability to produce contaminant-free water. The source of DI water used (both production source and individual carboy) and any available measurements such as specific conductivity should be recorded in the field notebook. At least 50 mL of DI water should be run through the DI carboy spout prior to using DI water for decontamination or blank sample purposes.

Specific decontamination procedures used should be recorded in field notebooks. Special procedures (i.e., dilute acid rinses, alternate solvent rinses) may be required for some projects. Any departures from the basic protocol given above for inorganics or organics should also be noted.

The subsections below suggest specific procedures relevant to equipment which may require frequent decontamination.

3.1 WATER LEVEL PROBES

The water level probe should generally be decontaminated between measurements by rinsing thoroughly with DI or distilled water. If groundwater is known to be contaminated with inorganic or organic constituents, however, additional rinses with soap and water or organic solvent may be required.

3.2 BAILERS

Reusable bailers normally will be stainless steel, teflon or PVC plastic (**NOTE: PVC is not to be used when organics are of concern**). A bailer can be used exclusively on one monitoring well (dedicated bailer) or used at multiple wells.

If dedicated bailers are used, they will be rinsed with tap water, then rinsed with DI water. The bailers then will be stored in capped PVC containers in Hydrometrics' storage area.

Bailers that are used in more than one well will be decontaminated by rinsing between wells. All bailers will be rinsed a minimum of three times with the water to be sampled before the sample is taken.

Disposable polypropylene twine will be used for bailing with new twine used for each well.

3.3 CONTAINERS

Containers may be used to composite or hold water or soil samples. Between samples, these containers must be decontaminated. Water sample containers also should be rinsed a minimum of three times with water to be sampled.

3.4 SOIL PISTON SAMPLER

The soil piston sampler will be decontaminated between sample sites by washing in warm water and detergent followed by rinses in tap water and DI water.

3.5 WATER FILTER

Most filtered water samples are processed through disposable cartridge filters using a peristaltic pump and disposable silicone tubing. However, if a reusable pressure water filter apparatus is used to filter water samples through flat 0.45 micron membranes, the filter apparatus must be decontaminated after each use with soap and water, tap water, and DI water as necessary. The filter apparatus should then be rinsed three times with the water to be sampled prior to taking the sample. Additionally, a volume of sample water is flushed through the new filter before the actual sample is taken (see **HF-SOP-73, Filtration of Water Samples**).

3.6 SOIL CORING DEVICES

Soil samples may be obtained from drill holes by use of coring devices. Split spoons or Shelby tubes can be used. These devices will be decontaminated by thoroughly washing between each sampling depth and sampling sites. Washing will include warm water and detergent followed by a rinse with tap water and DI water.

3.7 DRILLING RIG

Cross-contamination may occur from the drilling rig. The drilling rods and drilling bits will be washed with tap water between holes and, if necessary, they will be washed with warm water and detergent to remove all dirt or other potentially contaminated material.

If necessary, a pressurized washer (hot or cold water as appropriate) should be used. The detergent wash should be followed by a tap water rinse. This procedure is applicable for both **ORGANIC** and **INORGANIC** samples.

3.8 BACKHOE

Cross-contamination may occur from the backhoe. Therefore, the bucket and boom shall be washed with a pressurized washer capable of producing at least 1500 psi at a temperature of

120°F. The backhoe shall be washed with detergent water and then rinsed with municipal tap water. This procedure is applicable for both **ORGANIC** and **INORGANIC** samples.

4.0 RINSATE BLANK COLLECTION

Equipment used in collection of water samples often requires testing to assure that decontamination procedures are effective. This will be accomplished by rinsing of the decontaminated equipment with deionized water and measurement of the concentration of parameters of interest in this "blank sample". Sufficient blanks will be collected to ensure there is no cross-contamination caused by the sampling device. Details of rinsate blank collection procedures are contained in **HS-SOP-13, Rinsate Blank Collection**. Typically, blank collection and analysis procedures are also specified in the project work plan.

5.0 ASSOCIATED REFERENCES

HF-SOP-73 Filtration of Water Samples

HS-SOP-13 Rinsate Blank Collection

STANDARD OPERATING PROCEDURE

LABELING AND DOCUMENTATION OF SAMPLES HF-SOP-29

1.0 PURPOSE

Documentation of all samples is an important aspect of the project quality assurance program. This SOP specifically describes sample labeling procedure, but also addresses related aspects of sample documentation, all or some of which may be required by the project Quality Assurance Project Plan (QAPP).

2.0 EQUIPMENT

Sample documentation will involve use of some or all of the following:

1. Sample Identification Tag or Labels;
2. Chain-of-Custody Records;
3. Custody Seals;
4. Sample Analysis Form, or cover letter and parameter list; and
5. Field Notebooks.

These documents are sequentially numbered or sequentially paged.

All forms are completed using waterproof ink. Where necessary, the sample labels are protected with label protection tape.

3.0 SAMPLE IDENTIFICATION TAGS OR LABELS

Projects which may be the subject of litigation or are mandated by the EPA typically require serially numbered Sample Identification Tags. Sample labels (generally self-adhesive) are used in lieu of Sample Identification Tags for many projects and provide the same information, but are not serially numbered. The following discussion pertains specifically to use of Sample Identification Tags but, except for the next two paragraphs, is applicable to sample labeling in general.

Sample Identification Tags are distributed to field investigators and the serial numbers are recorded in project files and the field notebook. Individuals are accountable for each tag assigned to them. A tag is considered in their possession until it has been filled out, attached to

a sample and transferred to another individual with the corresponding Chain-of-Custody Record.

At no time are any Sample Identification Tags to be discarded. If any tags are lost, voided or damaged, the circumstances are noted in the appropriate field notebook immediately upon discovery and the Quality Assurance officer notified. At the completion of the field investigation activities, all unused Sample Identification Tags are returned and are checked against the list of assigned serial numbers.

Samples are removed from the sample location and transferred to a laboratory or other location for analysis. Before removal, however, a sample is often separated into fractions depending on the analysis to be performed. Each portion is preserved in accordance with prescribed procedures and each is identified with a separate Sample Identification Tag. In this case, each tag should indicate in the "Remarks" section that it is a split sample.

The information recorded on the tag or label includes:

- **Project Code.** An assigned Hydrometrics number (optional);
- **Station Number.** A code assigned by the Field Team Leader (optional), which identifies the station location;
- **Date.** A six-digit number indicating the year, month and day of collection;
- **Time.** A four-digit number indicating the 24-hour clock time of collection (for example, 1345 for 1:45 p.m.);
- **Sample Number.** The sample code number assigned to that sample and recorded in the field notebook;
- **Samplers.** Each sampler's name;
- **Preservative.** The tag should indicate whether a preservative is used, the type of preservative, and whether the sample has been field filtered;
- **Analysis.** The general type of analysis requested;
- **Tag Number.** A unique serial number, stamped on each tag (optional); and
- **Remarks.** The sampler's record of pertinent information (sample matrix, dissolved vs. total, highly contaminated, etc.).

The tag used for water, soil, and sediment samples contain an appropriate place for designating the sample as a grab or a composite, identifying the type of sample collected for analysis, and

indicating preservation, if any. The Sample Identification Tags are attached to or folded around each sample and are taped in place.

After collection, separation, identification and preservation, the sample is handled using chain-of-custody procedures as discussed in the **Chain-of-Custody Standard Operating Procedure (HF-SOP-5)**.

If the composite or grab sample is to be split, aliquoted portions are placed into similar sample containers. Sample Identification Tags are completed and attached to each container. Tags on quality control samples (e.g. blank, duplicate, blind field standards) are NOT marked to identify samples as such.

3.1 SAMPLE CODE NUMBERING OF DUPLICATE SAMPLES FOR XRF ANALYSES

When collecting duplicate soil samples to be analyzed by XRF techniques, the duplicate sample number is the same as the original sample number with the exception of a suffix "D" designation.

For example:	XYZ-9710-100	Original Sample Number
	XYZ-9710-100D	Duplicate Sample Number

4.0 CHAIN-OF-CUSTODY

Samples collected during any investigation may be used as evidence and their possession must be traceable from the time the samples are collected until they are introduced as evidence in legal proceedings. To document sample possession, Chain-of-Custody procedures are followed. These procedures are described in the **Chain-of-Custody Standard Operating Procedure (HF-SOP-5)**.

5.0 SAMPLE SHIPMENT

Samples are packaged properly for shipment as described in the **Packing and Shipping Samples Standard Operating Procedure (HF-SOP-4)** and dispatched to the appropriate laboratory for analysis.

If sent by mail, the package is registered with return receipt requested. If sent by overnight express courier or common carrier, a Bill of Lading is used. Air freight shipments are sent collect. Freight bills, Postal Service receipts and Bills of Lading are retained as part of the permanent documentation.

When Chain-of-Custody is required, a separate custody record must accompany each shipment. When transferring samples, the individuals relinquishing and receiving samples will sign, date

and note the time on the record. This record documents sample custody transfer from the sampler, often through another person, to the analyst at the laboratory.

6.0 SAMPLE ANALYSIS REQUEST

Samples sent to a laboratory for testing will be accompanied by a Request for Analytical Services or cover letter that describe the samples, specifies the testing required, and who is to receive the analytical report. Commonly, a standard analytical schedule is used for a project and this schedule should be attached to the Request for Analytical Services or cover letter.

7.0 FIELD NOTEBOOKS

A bound field notebook must be maintained by the Field Team Leader to provide a daily record of significant events, observations and measurements during field investigations. All entries should be signed and dated. All members of the field investigation should use this notebook. It should be kept as a permanent record.

These notebooks are intended to provide sufficient data and observations to enable participants to reconstruct events that occurred during the project and to refresh the memory of the field personnel if called upon to give testimony during legal proceedings. In a legal proceeding, notes, if referred to, are subject to cross-examination and are admissible as evidence.

8.0 CORRECTIONS TO DOCUMENTATION

Unless prohibited by weather conditions, all original data should be recorded in field notebooks, Sample Identification Tags and Chain-of-Custody Records are written with waterproof ink. None of these accountable serialized documents are to be destroyed or thrown away, even if they are illegible or contain inaccuracies that require a replacement document.

If an error is made on an accountable document assigned to one individual, that individual may make corrections simply by crossing a single line through the error and entering the correct information. The erroneous information should not be obliterated. Any subsequent error discovered on an accountable document should be corrected by the person who made the entry. All subsequent corrections must be initialed and dated.

9.0 SAMPLE NUMBERING

All samples of water and earth materials will be assigned a number by Hydrometrics. The numbers assigned for water samples will all use the project prefix and will be followed by a sequential number. The first sequential number will be 1 and a total of 5000 numbers are available for project water samples. A water sample may consist of several bottles if the sample is to be analyzed for several parameters, each requiring a different preservation technique. All

bottles for a sample will have the same sample number. Sampling data including site identification and sample numbers will be recorded in the field sampler's notebook to allow positive identification of the sample.

All samples of earth materials such as drilling cores from test wells and stream bottom sediment will be assigned a number by Hydrometrics. The numbers assigned for earth material samples will use the project prefix and will be followed by a sequential number. The first sequential number will be 5001 and a total of 4999 numbers are available for these samples. Sampling data and sample numbers for earth materials will be recorded and handled in the same manner as for water samples.

The laboratory will not be aware of the specific sample source. All quality control samples will use the same sample numbering method.

10.0 ASSOCIATED REFERENCES

National Water Well Association, 1986. RCRA Groundwater Monitoring Technical Enforcement Document. September.

U.S. EPA, 1986. Test Methods for Evaluating Solid Waste, SW-846, 3rd Edition, Vol. II: Field Manual Physical/Chemical Methods. November.

STANDARD OPERATING PROCEDURE

FIELD NOTEBOOKS HF-SOP-31

1.0 PURPOSE

Field notebooks are intended to provide sufficient data and observations to enable project participants to reconstruct events that occurred during the project and to refresh the memories of field personnel if called upon to give testimony during legal proceedings. In a legal proceeding, notes, if referred to, are subject to cross-examination and are admissible as evidence.

2.0 EQUIPMENT

Bound notebook with water resistant pages

Pen with indelible ink

3.0 PROCEDURE

A bound field notebook must be maintained by the Field Team Leader to provide a daily record of significant events, observations and measurements during field investigations. All members of the field investigation should use this notebook and initial their entries. It should be kept as a permanent record. All information called for in the Work Plan must be recorded, and any other data pertinent to the investigation at hand.

General information recorded in the field notebooks must include:

- Date and time;
- Weather conditions;
- Site name and description (if the first visit);
- Names of individuals participating in and/or observing sampling; and
- Unusual circumstances (unlocked well lid, missing staff gage, flood stage, etc.).

In addition, sampling personnel must record descriptions of sampling activities and parameters determined at each sampling station, appropriate to the type of media being sampled. This should include (but is not limited to) the following:

1) For water sampling (surface water and/or groundwater):

Water level measurement

Flow measurement

Sample collection:

Site number

Sample code number

Date and time

Bottle size(s)

Sample tag number (for Superfund investigations)

Bottle quality control number (for Superfund)

Dissolved Oxygen

Water Temperature

Specific conductivity

Calibration of Field Equipment

Preservative(s)

pH

Filtration

2) For soil sampling and/or sediment sampling:

Soil moisture conditions

Soil type (textural classification)

Sample collection

Site number

Sample code number

Date and time

Sample tag number (for Superfund investigations)

Sketch map of property, designated sample units and sample locations (for soil samples), or cross-section of stream sampled and approximate grab sample locations (for sediment samples).

Site descriptions should be adequate for someone unfamiliar with the site to relocate sampling point, and should be particularly detailed if this is the first sampling.

Other information deemed pertinent to sampling procedures and field conditions should be entered in field notebooks. This should include (at a minimum):

1. Notes confirming that calibration of field instruments (pH, SC, DO, etc.) was performed prior to sampling;
2. Notes detailing decontamination procedures performed (methods, any reagents used);
3. Notes describing the source of DI water used for decontamination or for collection of blanks; and
4. Notes describing shipment of samples to the laboratory and any enclosures included as part of such shipments (chain-of-custody, parameter lists, etc.).

All field notes should be entered into bound notebooks with indelible ink. Corrections should be made by deleting incorrect information with a single line and initialing the deletion in the field notebook. Each page should be numbered consecutively and signed by field personnel. All field records should be kept under custody of the Field Team Leader. Copies of the field records should be available for distribution to all team members for data reduction and report preparation.

STANDARD OPERATING PROCEDURE
MANAGEMENT AND VALIDATION
OF FIELD AND LABORATORY DATA®
HF-SOP-58

1.0 INTRODUCTION

This is a summary of procedures for data quality control at Hydrometrics. This plan contains the standard routines that have been established for management and validation of all field and laboratory data. The purpose of this plan is to:

- Summarize procedures used in the collection, input, and validation of data;
- Establish personnel responsibilities for each step in the process; and
- Describe documentation of this process and use of standard forms.

This process has been developed by Hydrometrics' Data Quality Department and deviations from this process must be approved by this department.

2.0 PROJECT SAMPLING, ANALYTICAL, AND QUALITY ASSURANCE PLANS

Collection of good quality data begins with good sampling and analytical plans (SAPs) and quality assurance program plans (QAPPs). Data does not become better with use, with validation, or with graphical presentation. Therefore, the greatest burden of responsibility for the quality of data is on the manager of each project and prior to sample collection and analysis. Preparers of SAPs and QAPPs are encouraged to seek assistance in preparation of SAPs and QAPPs from Data Quality Department personnel. They can advise you as to quality criteria and avoid inconsistencies in specifications that can make data validation troublesome, unnecessarily time consuming, and possibly meaningless. Copies of all SAPs and QAPPs must be submitted to the **Data Quality Department** to aid in the validation of data. Many potentially severe problems in data handling can be avoided by coordination with **Data Quality Department** personnel.

3.0 DATA FLOW AND DOCUMENTATION

Data flow in the management and validation process is summarized as follows:

1) **Initiate Sampling Event**

Project Manager or Field Supervisor initiates sampling events by submitting a Monitoring Description Form (HF-FORM-449) to the **Data Quality Department**.

The purpose of this form is to provide:

- A list of sites to be monitored (site code list) including information on any new sites;
- A description of the types and numbers of quality control samples to be submitted; and
- The analytical schedule (parameter list) for field and laboratory analyses.

These forms are kept on file in the **Data Quality Department's** sample event files (SEF) for ready reference.

2) **Generate Sample Code List and Start Sampling Event File**

Sample codes are needed for all sites where data is to be collected regardless of whether a water quality sample is collected (e.g., a surface water site where only flow is measured). The **Data Quality Department** will generate a sample code list which lists sample codes, site codes, and site descriptions for all planned monitoring sites. A set of extra sample code numbers to be used for additional unplanned samples or field data also will be developed. At this time, the **Data Quality Department** will also start a Sampling Event File in which all information and forms regarding the monitoring event will be filed.

3) **Collect and Record Monitoring Data**

All pertinent field data will be recorded on sampling forms. Data is originally recorded in a field notebook and data will be transcribed onto the sampling forms (**Identification and Description of Field Sampling Sites -- HF-FORM-407**) by field technicians. Sampling forms must be filled out completely. If data is not collected, an explanation must be given (e.g., stream was dry, staff gage is missing, Township and Range not known, etc.).

4) **Shipment of Samples**

All samples submitted to labs must be accompanied with:

- Chain-of-custody documentation (HF-FORM-1);
- Analytical parameter list; and
- Letter of transmittal to the laboratory.

ALL labs for ALL projects will receive a work plan (even in memo or letter form); or a QAPP.

An example transmittal letter is attached. **Transmittal letters must specify that analytical results are to be sent to the Data Quality Department.**

5) Submit Field Data and Completed Sampling Forms

Upon returning from the field, the **Field Technician** will submit a Data Quality Completion Form (HF-FORM-450) with the following data and forms to the **Data Quality Department**:

- Sample code list (revised to include any deviations from scheduled monitoring);
- Copy of field notes;
- Field forms;
- Copy of chain-of-custody documentation;
- Analytical parameter list;
- Copy of true values of standards and/or spikes used for QC purposes; and
- Letter of transmittal to the laboratory.

Information on new monitoring sites (name of site, site code, and type of site) must be approved by the **Project Manager** prior to input into the database system and any new sites must be described on the Monitoring Description Form (HF-FORM-449).

Samplers will give copies of all field data, including field notebooks, flow forms, sampling forms, and sample code lists, to the **Data Quality Department** for entry into the database. All computer-calculated flows will be performed by the **Data Quality Department**. To provide an additional check on the accuracy of computer-calculated streamflows, field technicians should also calculate flow data.

6) Input and Validation of Laboratory Data

The **Data Quality Department** will receive all laboratory data. When lab data has returned to Hydrometrics, the Project Manager will be notified by the department.

Laboratory data will be input and visually validated within a one week period. A memo explaining the findings of the validation, recommendations for laboratory retests, and an attached copy of the computer printout of the analysis will be given to the **Project Manager** or his designated representative. If laboratory retests or further validation are required, the **Project Manager** must request them from the **Data Quality Department**.

Please, do not contact laboratories directly! The Data Quality Department tracks data and retests from the labs. If you have a question about the status of data, ask Data Quality personnel to investigate for you.

7) **Field Technician Debriefing and Data Review**

The **Project Manager** and **Field Technician** should meet to discuss the monitoring results, performance on field quality control, the adequacy of the data, and any possible changes for future monitoring.

8) **Closing and Storage of Sampling Event File**

Upon receipt of all relevant documentation and approval of data validation by the **Project Manager** and **Field Technician**, the sampling event file will be labeled as "validated" and stored in the **Data Quality Department's** filing system.

9) **Summary Memo to Client and Administration File**

It is recommended, although not required, that the **Project Manager** provide the client with a memo summarizing results of the monitoring event. The memo should include:

- A description of the monitoring conducted;
- A draft copy of the validated data;
- A description of any anomalous data and laboratory retest results; and
- Any suggested changes for future monitoring.

The purposes of this memo are to keep the client updated on monitoring results and to notify the client contact concerning any important information about the sampling event. Therefore, summary memos should be customized for each client and also could include additional items such as hydrographs, photographs, graphs of water quality parameters vs time, etc. Copies of summary memos should be submitted to the sampling event file.

4.0 ELEMENTS OF DATA QUALITY PLAN

1) Monitoring Description Form (HF-FORM-449)

This form is to be used by the **Project Manager** or **Field Supervisor** to initiate a sampling event. The form provides information regarding what sites are to be sampled, what samples are to be collected and analyzed, and other information regarding the sampling event.

2) Data Quality Completion Form (HF-FORM-450)

This form is to be completed by the person requesting work to be done. It will be attached to the sampling information when it is submitted by field personnel. It will then remain in the sample event file so the progress of a sampling event can be quickly checked. The Data Quality Completion Form should be initialed immediately upon the completion of each step.

3) Sample Code List

The sample code list is a list assigned by the **Data Quality Department** **before** a sampling event. This list contains a sample number for each site which is to be sampled or observed. There will also be a description of each site.

4) Site Codes

Site codes will designate an actual physical location only. Matrix type will be specified in the sample number. For example, all samples collected from Monitoring Well number 1 (MW-1) will have MW-1 as their site code, whether they are soil samples, water samples, or other types of samples. When soil samples are taken from multiple depth intervals at the same site, each will be given an integer suffix which corresponds to the depth interval.

This will simplify identification of site names on maps and facilitate comparison of all types of sampling at a given site. Assignment of site codes to sampling sites is the responsibility of the **Project Manager**. This information must be provided to the **Data Quality Department**.

5) Sampling Event File

Laboratory and field data will be filed by sampling event. The **Data Quality Department** will begin a sampling event file for each new sample code list they generate. Each file will contain the following:

- Copy of the completed sample code list;
- Data quality completion form;
- Chain-of-custody forms;
- Letter of transmittal to the lab;
- Validation checklist;
- Any memos regarding the sampling event;
- All field notes and field data;
- Laboratory results; and
- Retest results.

All client files should have an information file set up which will contain the following:

- A copy of the original Work Plan and any revised Work Plans;
- Site maps with a list of site descriptions; and
- Special instructions for working with the data and any pertinent information that may apply to the data.

It is the responsibility of the **Project Manager** to make sure a copy of the three items above are received by the **Data Quality Department** as soon as they are made available.

All sample event files are in bright yellow jackets. Information files are in purple jackets, the validation file is teal and red files signify data that is for in-house use only and has not been input to the database. All files are stored in the file cabinets in the **Data Quality Department**.

6) Special Data Files

Data which is not typically entered into the water quality database will continue to be filed in the Project Files (main file cabinets). Special data includes pump testing data, infiltration data, survey data, etc. Each **Project Manager** is responsible for maintaining special data files as needed for individual projects.

The exception to this is a special sampling event that may be pertinent but the **Project Manager** has indicated the data should not be entered into the database. This data is stored in a red jacket file in the computer files. However, the practice of maintaining "special" files is discouraged. Because the data is not entered, it is not possible to conduct the normal validation steps and bad data may not be discovered in time to be retested (sample holding times are 6 months or less). Because the data does not show up in the database, experience has shown that the data will eventually become effectively lost or forgotten. Therefore, if data must be withheld from the database, it will be necessary for the Project Manager to provide a brief memo describing the data.

7) Data Validation Options and Checklists

There are three levels of data validation available:

Visual Validation: (HF-FORM-452)

This means data (lab and field) is checked for correctness of parameters, dates, site codes, site types, measurement basis, and units of measurement. Data values are compared with previous data for the site. Data will be printed out and returned to the **Project Manager** with a report indicating that a visual validation has been done and if anything out of the ordinary was found. This level is done for all projects.

Standard Validation: (HF-FORM-453)

All of the above visual validation is done plus the following: ion balance and statistical analysis are run, a check for completeness of field procedures, a check of quality control of field procedures, and data is flagged for exceedance of quality control limits. Data will be printed out and returned to the **Project Manager** with a validation report indicating acceptability of data.

EPA Validation: (HF-FORM-454)

This level of validation is time consuming and expensive and is typically only done for Superfund or RCRA projects. This validation includes the visual and standard validation procedures plus a check of frequency, precision, accuracy and completeness of all field and laboratory quality control procedures. The lab data is also flagged for exceedance in accordance with EPA Codes. Data will be printed out and returned to the **Project Manager** with a validation summary indicating acceptability of data per EPA Standards.

Validation procedures are documented through validation checklists. As each step in visual validation is done, the validation item is checked off and initialed. The validation checklist is provided to the **Project Manager** with a printout of the sampling results and a memo indicating any data problems. A copy of the checklist and memo will be filed

in the sample session file. This same procedure is used for Standard and EPA validations as well but, instead of a memo, a more detailed report and statistical summaries will be provided.

5.0 INDIVIDUAL RESPONSIBILITIES

The following are responsibilities required from the different personnel involved in monitoring and data quality at Hydrometrics:

Project Managers

Keep **Data Quality Department** personnel informed of upcoming sampling events, new projects, type of validation needed (a visual will always be done), changes in existing projects (e.g. changes in detection limits etc.) and deadlines for reports that will need any information from the Data Quality staff. Provide Work Plans, QAPPs, SAPs, and information on monitoring new sites to the **Data Quality Department** as soon as available.

The **Project Manager** will determine which field personnel will be Field Supervisor if the **Project Manager** is not available to head up the project.

Fill out the "Data Quality Completion" Form (**HF-FORM-450**) for the generation of sample code numbers and information pertaining to sample collection. Return to the **Data Quality Department** as soon as possible (at least 5 days prior to sampling if possible).

Meet with the field technician, go over the request form and give sample code numbers to field technician before sampling session.

Field Technicians

Meet with the **Project Manager** or **Field Supervisor** to get information and sample code numbers prior to sampling event.

Fill out the "Data Quality Completion" form (**HF-FORM-450**), attach it to the sampling information and give it to the Data Quality Department within 5 days of returning to the office. Make sure to indicate on the cover letter to the lab or Chain-of-Custody that analysis is to be returned to the **Data Quality Department**.

Data Quality Department

When the lab analyses arrive at Hydrometrics, the project manager or other designated project staff will be notified that the data has been received by the **Data Quality Department**.

All data will be input and visually validated within a one week period (field and lab data arrive separately so each will receive a one week input time). The exceptions are large sampling packages and CLP packages which take a longer period of time.

- If more extensive validation is required, it will be done and a copy of the data set and a memo of the findings will be given to the project manager; and
- A file will be created and all data will be filed in the **Data Quality Departments'** filing system. The final data report will be attached to the "pink" signed validation report and filed in a teal jacket.

6.0 ASSOCIATED REFERENCES

HF-FORM-407 IDENTIFICATION AND DESCRIPTION OF
FIELD SAMPLING SITES

HF-FORM-449 MONITORING DESCRIPTION FORM

HF-FORM-450 DATA QUALITY COMPLETION FORM

HF-FORM-452 VISUAL VALIDATION CHECKLIST FORM

HF-FORM-453 STANDARD VALIDATION CHECKLIST FORM

HF-FORM-454 EPA VALIDATION CHECKLIST FORM

Laboratory Transmittal letter

STANDARD OPERATING PROCEDURE

PROCEDURE FOR COLLECTING SURFACE SOIL SAMPLES®

HS-SOP-6

1.0 PURPOSE

This SOP describes the procedure for collecting a surface soil sample from the top 1 to 2 inches for subsequent chemical analysis.

Soil types and soil characteristics can vary considerable within and between sampling sites. It is important, therefore, that detailed records be taken; particularly of the sampling location, depth, and soil characteristics such as grain size and color. While this SOP describes a general procedure for collection surface soil samples, because of soil heterogeneity issues, modifications to this procedure may be appropriate depending on site-specific conditions and data collection objectives. Therefore, the project specific sampling and analysis plan should be consulted for any deviations to the procedure described below.

2.0 EQUIPMENT

- Stainless steel spoon or plastic spoon;
- Wide mouth glass jar (organics);
- 1 gallon size Zip-lock plastic bags (metals);
- Surgical gloves;
- Measuring tape; and
- Field notebook.

When sampling for metals, a stainless steel or plastic spoon should be used for collecting the sample. Sampling tools which are plated with chrome or other materials are to be avoided.

3.0 PROCEDURE

1. Locate the site to be sampled and record the site name and location in the field notebook (**HF-SOP-31**). The notes and drawings should outline the property boundary, location of sample units and sample sites, sample site names, sample depths and sample numbers, as appropriate.
2. An approximate 1x1 foot area should be delineated with the sample collected from the top 1 to 2 inches of soil within this area. A stainless steel or plastic spoon should be used to collect the sample. Generally, between 100 and 500

grams of soil is required. If more sample is required the sampling area should be expanded without increasing the depth of sampling.

3. If a sod layer is present, sod should be removed or folded back prior to sampling. Sod should not be included on the surface soil sample unless specifically required by the work plan. In this case, refer to HS-SOP-12, Procedure for Sampling Sod.
4. For grab samples, soil collected using a stainless steel or plastic spoon (at the surface or at depth) should be placed directly into the sample container. For metals samples a plastic zip-lock bag is an appropriate container. For organic samples, a glass container is required unless otherwise specified. Generally, coarse material should be excluded from the sample (greater than approximately 1/4 inch where feasible).
5. For composite samples or field split samples, the soil grab sample should be transferred from the stainless steel or plastic spoon to a stainless steel mixing bowl, Teflon tray, or similar device free of potential sample contaminants. Once all grab samples are collected, the sample should be thoroughly mixed prior to transferring the sample to the sample container. Note that samples for volatile organic constituents should not be mixed to minimize potential losses to the atmosphere. Alternately, composite samples may be obtained by transferring each grab sample directly to the plastic sample bag, provided there is sufficient room in the sample to ensure thorough mixing of the sample within the bag. (Since the laboratory may only use a small portion of the total sample, it is important that the sample be thoroughly mixed so that the analysis is representative of all sample grab locations.)
6. Sample containers should be labeled, at a minimum, with sample date and sample number to permit cross referencing with the field notebook. If the sample is not to be submitted as a completely blind sample, other information may also be appropriate including sample depth, station identification, soil type. Refer to **HF-SOP-29**, Labeling and Documentation of Samples.
7. Refer to **HF-SOP-5**, Chain-of-Custody, and **HF-SOP-4**, Packing and Shipping Samples for sample handling procedures.
8. All equipment which contact the soil should be decontaminated after collecting the sample. Refer to **HF-SOP-7**, Decontamination of Sampling Equipment.

4.0 ASSOCIATED REFERENCES

HF-SOP-31 FIELD NOTEBOOKS

HF-SOP-29 LABELING AND DOCUMENTATION OF SAMPLES

HF-SOP-5 CHAIN-OF-CUSTODY

HF-SOP-4 PACKING AND SHIPPING SAMPLES

HF-SOP-7 DECONTAMINATION OF SAMPLING EQUIPMENT

STANDARD OPERATING PROCEDURE

RINSATE BLANK COLLECTION®

HS-SOP-13

1.0 PURPOSE

The purpose of this procedure is to collect Quality Control blanks that can be used to assess the potential for sample cross-contamination.

2.0 EQUIPMENT

Sampling equipment to be tested
Field Notebook
Carboy with deionized water
Plastic catch basin

Surgical gloves
Sample bottles
Chain-of-Custody documentation

3.0 PROCEDURE

Collection and analysis of rinsate (equipment) blanks is intended to provide information on the contamination and cross-contamination potential introduced by sampling equipment and methods. Any surfaces which contact samples may contribute analytes of interest to the sample, thereby creating the possibility of positive bias in analytical results. Decontamination procedures (see **HF-SOP-7**) have been designed to minimize the likelihood of sample contamination. The effectiveness of decontamination of sampling equipment is monitored by rinsing equipment with deionized water, and measuring the concentration of parameters of interest in the resulting "blank" sample.

In general, any equipment used to collect, composite, or store samples that directly contacts the sample should be subjected to the rinsate blank procedure. Examples include pumps, filters, bailers, bottles, coring devices, shovels, trowels, and large containers used for compositing a number of samples. Other items may also require decontamination and testing through collection of rinsate blanks. The following steps describe basic rinsate blank collection procedures. Specific methods used should be documented in field notebooks whenever rinsate blanks are collected.

1. Obtain sample equipment and be sure it has been decontaminated using appropriate procedures in **HF-SOP-7** (Decontamination of Sampling Equipment).

2. Run about 50 mLs of water through carboy spigot to clean it out before collecting blank sample.
3. Place the equipment under the carboy spigot and inside the catch basin. The catch basin can be made by cutting the top off a sample bottle.
4. With surgical gloves on, open the spigot and run water over and/or through the sampling equipment. The water should contact the area of the equipment that is likely to contact the material to be sampled. Use only enough DI water to completely rinse the equipment surface. Excessive volumes of rinse water can dilute chemical concentrations in the rinsate blank, with a resulting loss of information.
5. Obtain enough water in the catch basin for the desired analysis.
6. Carefully pour water from the catch basin into the appropriate sample container for the parameters of interest, and add any necessary preservatives.
7. Document rinsate procedures in field notebooks, including a list of equipment rinsed, volumes of deionized water used, and the source of the deionized water.

STANDARD OPERATING PROCEDURE

SOIL SAMPLING PROCEDURE FOR TEST PITS HS-SOP-57

1.0 PURPOSE

This procedure describes the technique for collecting soil samples from test pits excavated with a backhoe.

2.0 EQUIPMENT

- Stainless steel trowel;
- Ziplock plastic bags (inorganic samples) or glass jars with teflon covers (organic samples);
- Surgical gloves; and
- Ladder.

3.0 PROCEDURE

1. Locate site on map, record site description (**Identification and Description of Field Sampling Sites - HF-SOP-2** and use form **HF-FORM-407**).
2. Direct the backhoe operator to excavate the pit. For pits deeper than 5 feet, one pit face will be sloped in accordance with OSHA requirements.
3. Using the stainless steel trowel, collect samples at depths specified in project work plan. First scrape area of pit wall to be sampled, discarding these first scrapings, then scrape again to peel off sample of uniform thickness throughout depth to be sampled. Be sure to clean trowel between depths sampled.
4. For grab samples, soil collected using a stainless steel or plastic spoon (at the surface or at depth) should be placed directly into the sample container. For metals samples a plastic zip-lock bag is an appropriate container. For organic samples, a glass container is required unless otherwise specified. Generally, coarse material should be excluded from the sample (greater than approximately 1/4 inch where feasible).
5. For composite samples or field split samples, the soil grab sample should be transferred from the stainless steel or plastic spoon to a stainless steel mixing bowl, Teflon tray, or similar device free of potential sample contaminants. Once all grab samples are collected, the sample should be thoroughly mixed prior to transferring the sample to the sample container. Note that samples for volatile organic constituents should not be mixed to minimize potential losses to the atmosphere. Alternately, composite samples may be obtained by transferring each

grab sample directly to the plastic sample bag, provided there is sufficient room in the sample to ensure thorough mixing of the sample within the bag. (Since the laboratory may only use a small portion of the total sample, it is important that the sample be thoroughly mixed so that the analysis is representative of all sample grab locations.)

6. Record date and time, depth of samples, soil description, etc. on HF-FORM-703 (Test Pit Field Form). A blank form is attached.
7. Direct backhoe operator to backfill pit.
8. Decontaminate trowel and backhoe bucket in accordance with between sample sites, in accordance with HF-SOP-7 (Decontamination of Sampling Equipment).

STANDARD OPERATING PROCEDURE
FIELD TEST PIT LOG COVER FORM©
(HF-FORM-703)

HYDROMETRICS, INC.®

Test Pit Name:

Field Log Cover Form

Project Information

Name _____
Client _____
Property Owner _____
Project Number _____

Point Identifying Information

Point ID _____
County _____
State _____
Legal Desc. _____
Desc. Location _____
Samp. # Prefix _____
Hole Depth _____
Elevation (GS) _____
Elevation (MP) _____
Northing _____
Easting _____

Excavation Information

Date Started _____
Date Finished _____
Recorded By _____
Equipment Owner _____
Equipment Operator _____
Excavation Method _____
Excavation Dimensions (L x W x D) _____

Measuring Information

Datum _____
Static Water Level _____
Static Water Date _____
MP Description _____
MP Height _____

Signature

**STANDARD OPERATING PROCEDURE
TEST PIT FIELD FORM: GRAPHICAL LOGS©
(HF-FORM-703)**

HYDROMETRICS, INC.®						Photos: Y N		Test Pit Name:			
Test Pit Field Form: Graphical Logs						Personnel:		Page of			
Sample Collection Log						Geological Log					
Depth	Length	Number	Date	Time	Sample Type	Notes	Top Depth	Bot. Depth	Hatching	Material Name	Unit Name
							Description				
							Description				
							Description				
							Description				

Graphical Description (optional)



United States
Environmental Protection
Agency

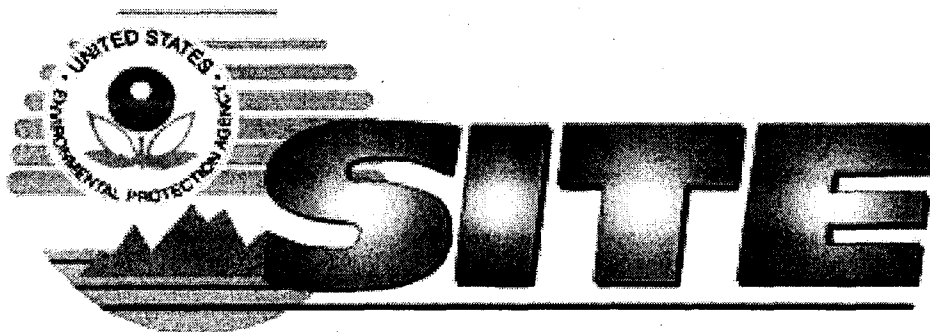
Office of Research and
Development
Washington, DC 20460

EPA/540/R-06/003
February 2006

Innovative Technology Verification Report

XRF Technologies for Measuring Trace Elements in Soil and Sediment

Niton XLi 700 Series XRF Analyzer





United States
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XRF Technologies for Measuring Trace Elements in Soil and Sediment

Niton XLt 700 Series XRF Analyzer



X-ray Fluorescence (XRF) Instruments Frequently Asked Questions (FAQ)

The following frequently asked questions (FAQs) address the proper use of field-portable X-ray fluorescence (FP-XRF) instruments to collect data at hazardous waste sites for use in the Integrated Exposure Uptake Biokinetic Model for Lead in Children (IEUBK model). Additional questions regarding the use of XRF instruments to collect data for use with the IEUBK model can be submitted to the TRW Technical Assistance Hotline either by telephone (1-866-282-8622) or e-mail. Please refer to the Lead Workgroups [Technical Assistance](#) page for further information.

What are the advantages of measuring lead concentration with a field-portable XRF (FP-XRF) instrument?

When lead is the main element of potential concern, analysis of samples by FP-XRF (and fixed-base XRF) instruments can offer considerable reductions in cost and time compared to standard CLP methods. Average sample throughput for *ex situ* (see third FAQ below for definition) analysis generally varies from 50 to 100 samples per day, depending on the number of analytes, the particular analyzer used, and the soil preparation protocol. *In situ* (see third FAQ below for definition) analysis allows a greater number of analyses at a given site because little or no sample preparation is performed; however, the loss of precision and accuracy in this mode of operation precludes quantitative site characterization. With FP-XRF instruments, measurements of soil lead concentration can be generated in real-time, allowing decision making in the field regarding the need for additional sampling or further remediation (provided that proper QC procedures are followed - see below). Another advantage of FP-XRF analysis over standard laboratory analysis is that the procedure does not generate investigation-derived waste, because it does not require solvent or acid extraction techniques that are employed by laboratory methods.

What media can be analyzed with an FP-XRF instrument?

XRF instruments are typically used to measure lead in soil, dust, and paint samples. Special techniques allow for measurements of air lead. XRF instruments are not typically used for measuring lead in water.

How is a FP-XRF instrument used to measure lead concentration in soil?

Some FP-XRF instruments can be placed directly on the soil surface for *in situ* measurements. The FP-XRF instrument measures the metal content of the sample over a surface area of approximately one square centimeter (1 cm²) to a depth of approximately 2 millimeters (2 mm), displaying lead concentration in parts per million (ppm). Other FP-XRF instruments require that soil samples are collected and placed in a sample cup that is then placed in a covered sample chamber for analysis (*ex situ* analysis). Most FP-XRF instruments can perform both *in situ* and *ex situ* analyses. Because of limitations on precision and accuracy, *in situ* analysis provides qualitative results. By contrast, *ex situ* analysis can provide semi-quantitative or quantitative results, depending upon the amount of preparation of the soil sample prior to analysis and the calibration standards used. Due to the inherent heterogeneity of soil, *ex situ* analysis is the preferred method because the soil can be homogenized to provide a sample that is more representative of the concentration of lead at the location from which it was collected.

What is the quality of the data that are generated by an XRF instrument?

Historically, FP-XRF techniques were generally viewed as being suitable only for screening; however,

recent advances in technology and instrumentation now permit this method to yield results that are fully comparable with CLP methods for soil and dust. The EPA Environmental Technology Verification (ETV) program evaluated 7 FP-XRF analyzers and found the precision-based detection limits ranged from 30 to 165 ppm in soil, and the relative standard deviations (RSDs) at 5 to 10 times the detection limit were less than 10% (EPA, 1998a-f). The ETV program also found that measurements of soil lead concentrations made with FP-XRF analyzers compared well with those made by fixed-based reference laboratories using CLP methods; correlations between the FP-XRF measurements and reference laboratories ranged from 0.85 to 0.97. Once a relationship has been established between FP-XRF results and CLP lab data for a specific site, FP-XRF can provide inexpensive, real-time data concerning lead concentrations in soil. Other studies have also shown good correlation between lead levels measured by CLP and by XRF (including both field-portable and fixed-base measurements)¹.

Has EPA published standard operating procedures for the use of FP-XRF instruments?

Methods for XRF analysis are described in SW-846 (EPA, 1998g), and a FP-XRF protocol is available from the EPA Region 1 [Web site](#). However, it is important that a site-specific QC plan be established to ensure that the data quality objectives (DQOs) for the site are achieved. The Superfund Lead-Contaminated Residential Sites Handbook (EPA, 2003) and the Abandoned Mine Site Characterization and Cleanup Handbook (EPA, 2000a) also provide suggestions on the proper use of FP-XRF. For example, the Superfund Lead-Contaminated Residential Sites Handbook (EPA, 2003) suggests 20 percent of the samples be analyzed by both the FP-XRF instrument and a CLP laboratory to develop a site-specific statistical relationship between the two methods. Once the accuracy and precision of the FP-XRF results have been determined (and assuming they satisfy the DQO requirements of the project), the number of laboratory confirmatory samples could be reduced (e.g., to 5 percent). Inherent in this comparison is the determination of the type of sample preparation (e.g., drying and sieving) that is required to ensure that the relationship is consistent (EPA, 2003). Confirmatory analysis should be focused on samples where the FP-XRF instrument indicates the lead concentration is near the soil cleanup level, if a cleanup level has been determined.

What factors can compromise the quality of FP-XRF data?

There are a number of factors, known as interferences, that can affect the detection limits and precision of FP-XRF instruments. Some interferences can be inherent in the method of analysis, whereas others are the result of the instrument's setup, such as calibration methods. Other interferences may arise from outside sources, such as the sample matrix. The following is a brief overview of some factors that can affect the quality of FP-XRF data:

Sample matrix effects include particle size, uniformity, homogeneity, and condition of the surface. The ETV reports (EPA, 1998a-f) indicate the heterogeneity of the sample generally has the greatest effect on comparability with confirmatory samples. Every effort should be made to homogenize soil samples thoroughly before analysis. One way to reduce particle size effects is to sieve all soil samples. Guidance on sieving samples for lead analysis is available in the TRW short sheet on soil sampling and analysis (EPA, 2000b).

Moisture content above 20 percent can interfere with the analysis, since moisture alters the soil matrix for which the field-portable XRF has been calibrated. This problem can be minimized by drying, preferably in a convection or toaster oven. Drying by microwave can increase variability between the results and can cause arcing if fragments of metal are present in the sample. At some sites, oven drying is an important part of the sample preparation protocol for quantitative analysis to ensure sample

¹Validation references listed in the reference list are marked with an asterisk (*).

homogeneity. The effect of moisture on XRF results is not universal, and the requirement for drying should be determined at each site.

Inconsistent positioning of samples in front of the probe window is a potential source of error because the X-ray signal decreases as the distance from the radioactive source increases. Maintaining a consistent distance between the window and the sample minimizes this problem. For best results, the window of the probe should be in direct contact with the sample.

Chemical matrix effects also can occur as X-ray absorption and enhancement phenomena. The presence of certain metals can interfere with the analysis of certain other metals. For example, iron tends to absorb copper X-rays, whereas chromium levels will be enhanced in the presence of iron. These effects can be corrected mathematically through the field-portable XRF instrument's software. Vendors can typically provide the necessary information during the planning stage to anticipate these interferences.

Instrument resolution limitations may cause problems in analyzing some elements. If the energy difference between the characteristic X-rays of two elements (as measured in eV) is less than the resolution of the detector in eVs, then the detector will not be able to resolve the peaks. In other words, if two peaks are 240 eVs apart, but the resolution of the detector is 270 eV, the detector will have difficulty in differentiating those peaks. A common example is the overlap of the arsenic K peak with the lead L peak. With the use of mathematical corrections that subtract the lead interference, lead can be measured from the lead L peak and arsenic can be measured from the arsenic K peak. However, concentrations of arsenic cannot be calculated efficiently for samples that have lead-to-arsenic ratios of 10 to 1 or more, because the lead peak will overwhelm the arsenic peak completely. Additional information concerning interference from arsenic is available from U.S. EPA Region 8 (U.S. EPA, 2001b) and the ETV FP-XRF reports (EPA, 1998a-f).

Where can I find additional information regarding the use of FP-XRF analyzers?

In addition to the sources cited above, other sources of information include *Lead-Safe Yards Developing and Implementing a Monitoring, Assessment, and Outreach Program for Your Community* (EPA, 2001a) and an EPA document that compares FP-XRF instruments (EPA, 2001b). The EPA Technology Innovation Program's Web site provides documents that describe the use of FP-XRF analyzers in the TRIAD approach to site assessment.

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METHOD 6200

FIELD PORTABLE X-RAY FLUORESCENCE SPECTROMETRY FOR THE DETERMINATION OF ELEMENTAL CONCENTRATIONS IN SOIL AND SEDIMENT

SW-846 is not intended to be an analytical training manual. Therefore, method procedures are written based on the assumption that they will be performed by analysts who are formally trained in at least the basic principles of chemical analysis and in the use of the subject technology.

In addition, SW-846 methods, with the exception of required method use for the analysis of method-defined parameters, are intended to be guidance methods which contain general information on how to perform an analytical procedure or technique which a laboratory can use as a basic starting point for generating its own detailed Standard Operating Procedure (SOP), either for its own general use or for a specific project application. The performance data included in this method are for guidance purposes only, and are not intended to be and must not be used as absolute QC acceptance criteria for purposes of laboratory accreditation.

1.0 SCOPE AND APPLICATION

1.1 This method is applicable to the in situ and intrusive analysis of the 26 analytes listed below for soil and sediment samples. Some common elements are not listed in this method because they are considered "light" elements that cannot be detected by field portable x-ray fluorescence (FPXRF). These light elements are: lithium, beryllium, sodium, magnesium, aluminum, silicon, and phosphorus. Most of the analytes listed below are of environmental concern, while a few others have interference effects or change the elemental composition of the matrix, affecting quantitation of the analytes of interest. Generally elements of atomic number 16 or greater can be detected and quantitated by FPXRF. The following RCRA analytes have been determined by this method:

Analytes	CAS Registry No.
Antimony (Sb)	7440-36-0
Arsenic (As)	7440-38-0
Barium (Ba)	7440-39-3
Cadmium (Cd)	7440-43-9
Chromium (Cr)	7440-47-3
Cobalt (Co)	7440-48-4
Copper (Cu)	7440-50-8
Lead (Pb)	7439-92-1
Mercury (Hg)	7439-97-6
Nickel (Ni)	7440-02-0
Selenium (Se)	7782-49-2
Silver (Ag)	7440-22-4
Thallium (Tl)	7440-28-0
Tin (Sn)	7440-31-5

Analytes	CAS Registry No.
Vanadium (V)	7440-62-2
Zinc (Zn)	7440-66-6

In addition, the following non-RCRA analytes have been determined by this method:

Analytes	CAS Registry No.
Calcium (Ca)	7440-70-2
Iron (Fe)	7439-89-6
Manganese (Mn)	7439-96-5
Molybdenum (Mo)	7439-93-7
Potassium (K)	7440-09-7
Rubidium (Rb)	7440-17-7
Strontium (Sr)	7440-24-6
Thorium (Th)	7440-29-1
Titanium (Ti)	7440-32-6
Zirconium (Zr)	7440-67-7

1.2 This method is a screening method to be used with confirmatory analysis using other techniques (e.g., flame atomic absorption spectrometry (FLAA), graphite furnace atomic absorption spectrometry (GFAA), inductively coupled plasma-atomic emission spectrometry, (ICP-AES), or inductively coupled plasma-mass spectrometry, (ICP-MS)). This method's main strength is that it is a rapid field screening procedure. The method's lower limits of detection are typically above the toxicity characteristic regulatory level for most RCRA analytes. However, when the obtainable values for precision, accuracy, and laboratory-established sensitivity of this method meet project-specific data quality objectives (DQOs), FPXRF is a fast, powerful, cost effective technology for site characterization.

1.3 The method sensitivity or lower limit of detection depends on several factors, including the analyte of interest, the type of detector used, the type of excitation source, the strength of the excitation source, count times used to irradiate the sample, physical matrix effects, chemical matrix effects, and interelement spectral interferences. Example lower limits of detection for analytes of interest in environmental applications are shown in Table 1. These limits apply to a clean spiked matrix of quartz sand (silicon dioxide) free of interelement spectral interferences using long (100 -600 second) count times. These sensitivity values are given for guidance only and may not always be achievable, since they will vary depending on the sample matrix, which instrument is used, and operating conditions. A discussion of performance-based sensitivity is presented in Sec. 9.6.

1.4 Analysts should consult the disclaimer statement at the front of the manual and the information in Chapter Two for guidance on the intended flexibility in the choice of methods, apparatus, materials, reagents, and supplies, and on the responsibilities of the analyst for demonstrating that the techniques employed are appropriate for the analytes of interest, in the matrix of interest, and at the levels of concern.

In addition, analysts and data users are advised that, except where explicitly specified in a regulation, the use of SW-846 methods is *not* mandatory in response to Federal testing requirements. The information contained in this method is provided by EPA as guidance to be used by the analyst and the regulated community in making judgments necessary to generate results that meet the data quality objectives for the intended application.

1.5 Use of this method is restricted to use by, or under supervision of, personnel appropriately experienced and trained in the use and operation of an XRF instrument. Each analyst must demonstrate the ability to generate acceptable results with this method.

2.0 SUMMARY OF METHOD

2.1 The FPXRF technologies described in this method use either sealed radioisotope sources or x-ray tubes to irradiate samples with x-rays. When a sample is irradiated with x-rays, the source x-rays may undergo either scattering or absorption by sample atoms. This latter process is known as the photoelectric effect. When an atom absorbs the source x-rays, the incident radiation dislodges electrons from the innermost shells of the atom, creating vacancies. The electron vacancies are filled by electrons cascading in from outer electron shells. Electrons in outer shells have higher energy states than inner shell electrons, and the outer shell electrons give off energy as they cascade down into the inner shell vacancies. This rearrangement of electrons results in emission of x-rays characteristic of the given atom. The emission of x-rays, in this manner, is termed x-ray fluorescence.

Three electron shells are generally involved in emission of x-rays during FPXRF analysis of environmental samples. The three electron shells include the K, L, and M shells. A typical emission pattern, also called an emission spectrum, for a given metal has multiple intensity peaks generated from the emission of K, L, or M shell electrons. The most commonly measured x-ray emissions are from the K and L shells; only metals with an atomic number greater than 57 have measurable M shell emissions.

Each characteristic x-ray line is defined with the letter K, L, or M, which signifies which shell had the original vacancy and by a subscript alpha (α), beta (β), or gamma (γ) etc., which indicates the higher shell from which electrons fell to fill the vacancy and produce the x-ray. For example, a K_α line is produced by a vacancy in the K shell filled by an L shell electron, whereas a K_β line is produced by a vacancy in the K shell filled by an M shell electron. The K_α transition is on average 6 to 7 times more probable than the K_β transition; therefore, the K_α line is approximately 7 times more intense than the K_β line for a given element, making the K_α line the choice for quantitation purposes.

The K lines for a given element are the most energetic lines and are the preferred lines for analysis. For a given atom, the x-rays emitted from L transitions are always less energetic than those emitted from K transitions. Unlike the K lines, the main L emission lines (L_α and L_β) for an element are of nearly equal intensity. The choice of one or the other depends on what interfering element lines might be present. The L emission lines are useful for analyses involving elements of atomic number (Z) 58 (cerium) through 92 (uranium).

An x-ray source can excite characteristic x-rays from an element only if the source energy is greater than the absorption edge energy for the particular line group of the element, that is, the K absorption edge, L absorption edge, or M absorption edge energy. The absorption edge energy is somewhat greater than the corresponding line energy. Actually, the K absorption edge energy is approximately the sum of the K, L, and M line energies of the particular element, and the L absorption edge energy is approximately the sum of the L and M line energies. FPXRF is more sensitive to an element with an absorption edge energy close to but less than

the excitation energy of the source. For example, when using a cadmium-109 source, which has an excitation energy of 22.1 kiloelectron volts (keV), FPXRF would exhibit better sensitivity for zirconium which has a K line energy of 15.77 keV than to chromium, which has a K line energy of 5.41 keV.

2.2 Under this method, inorganic analytes of interest are identified and quantitated using a field portable energy-dispersive x-ray fluorescence spectrometer. Radiation from one or more radioisotope sources or an electrically excited x-ray tube is used to generate characteristic x-ray emissions from elements in a sample. Up to three sources may be used to irradiate a sample. Each source emits a specific set of primary x-rays that excite a corresponding range of elements in a sample. When more than one source can excite the element of interest, the source is selected according to its excitation efficiency for the element of interest.

For measurement, the sample is positioned in front of the probe window. This can be done in two manners using FPXRF instruments, specifically, in situ or intrusive. If operated in the in situ mode, the probe window is placed in direct contact with the soil surface to be analyzed. When an FPXRF instrument is operated in the intrusive mode, a soil or sediment sample must be collected, prepared, and placed in a sample cup. The sample cup is then placed on top of the window inside a protective cover for analysis.

Sample analysis is then initiated by exposing the sample to primary radiation from the source. Fluorescent and backscattered x-rays from the sample enter through the detector window and are converted into electric pulses in the detector. The detector in FPXRF instruments is usually either a solid-state detector or a gas-filled proportional counter. Within the detector, energies of the characteristic x-rays are converted into a train of electric pulses, the amplitudes of which are linearly proportional to the energy of the x-rays. An electronic multichannel analyzer (MCA) measures the pulse amplitudes, which is the basis of qualitative x-ray analysis. The number of counts at a given energy per unit of time is representative of the element concentration in a sample and is the basis for quantitative analysis. Most FPXRF instruments are menu-driven from software built into the units or from personal computers (PC).

The measurement time of each source is user-selectable. Shorter source measurement times (30 seconds) are generally used for initial screening and hot spot delineation, and longer measurement times (up to 300 seconds) are typically used to meet higher precision and accuracy requirements.

FPXRF instruments can be calibrated using the following methods: internally using fundamental parameters determined by the manufacturer, empirically based on site-specific calibration standards (SSCS), or based on Compton peak ratios. The Compton peak is produced by backscattering of the source radiation. Some FPXRF instruments can be calibrated using multiple methods.

3.0 DEFINITIONS

- 3.1 FPXRF -- Field portable x-ray fluorescence.
- 3.2 MCA -- Multichannel analyzer for measuring pulse amplitude.
- 3.3 SSCS -- Site-specific calibration standards.
- 3.4 FP -- Fundamental parameter.
- 3.5 ROI -- Region of interest.

3.6 SRM -- Standard reference material; a standard containing certified amounts of metals in soil or sediment.

3.7 eV -- Electron volt; a unit of energy equivalent to the amount of energy gained by an electron passing through a potential difference of one volt.

3.8 Refer to Chapter One, Chapter Three, and the manufacturer's instructions for other definitions that may be relevant to this procedure.

4.0 INTERFERENCES

4.1 The total method error for FPXRF analysis is defined as the square root of the sum of squares of both instrument precision and user- or application-related error. Generally, instrument precision is the least significant source of error in FPXRF analysis. User- or application-related error is generally more significant and varies with each site and method used. Some sources of interference can be minimized or controlled by the instrument operator, but others cannot. Common sources of user- or application-related error are discussed below.

4.2 Physical matrix effects result from variations in the physical character of the sample. These variations may include such parameters as particle size, uniformity, homogeneity, and surface condition. For example, if any analyte exists in the form of very fine particles in a coarser-grained matrix, the analyte's concentration measured by the FPXRF will vary depending on how fine particles are distributed within the coarser-grained matrix. If the fine particles "settle" to the bottom of the sample cup (i.e., against the cup window), the analyte concentration measurement will be higher than if the fine particles are not mixed in well and stay on top of the coarser-grained particles in the sample cup. One way to reduce such error is to grind and sieve all soil samples to a uniform particle size thus reducing sample-to-sample particle size variability. Homogeneity is always a concern when dealing with soil samples. Every effort should be made to thoroughly mix and homogenize soil samples before analysis. Field studies have shown heterogeneity of the sample generally has the largest impact on comparability with confirmatory samples.

4.3 Moisture content may affect the accuracy of analysis of soil and sediment sample analyses. When the moisture content is between 5 and 20 percent, the overall error from moisture may be minimal. However, moisture content may be a major source of error when analyzing samples of surface soil or sediment that are saturated with water. This error can be minimized by drying the samples in a convection or toaster oven. Microwave drying is not recommended because field studies have shown that microwave drying can increase variability between FPXRF data and confirmatory analysis and because metal fragments in the sample can cause arcing to occur in a microwave.

4.4 Inconsistent positioning of samples in front of the probe window is a potential source of error because the x-ray signal decreases as the distance from the radioactive source increases. This error is minimized by maintaining the same distance between the window and each sample. For the best results, the window of the probe should be in direct contact with the sample, which means that the sample should be flat and smooth to provide a good contact surface.

4.5 Chemical matrix effects result from differences in the concentrations of interfering elements. These effects occur as either spectral interferences (peak overlaps) or as x-ray absorption and enhancement phenomena. Both effects are common in soils contaminated with heavy metals. As examples of absorption and enhancement effects; iron (Fe) tends to absorb copper (Cu) x-rays, reducing the intensity of the Cu measured by the detector, while chromium (Cr) will be enhanced at the expense of Fe because the absorption edge of Cr is slightly lower in energy than the fluorescent peak of iron. The effects can be corrected mathematically through the use of fundamental parameter (FP) coefficients. The effects also can be compensated for using SSCS, which contain all the elements present on site that can interfere with one another.

4.6 When present in a sample, certain x-ray lines from different elements can be very close in energy and, therefore, can cause interference by producing a severely overlapped spectrum. The degree to which a detector can resolve the two different peaks depends on the energy resolution of the detector. If the energy difference between the two peaks in electron volts is less than the resolution of the detector in electron volts, then the detector will not be able to fully resolve the peaks.

The most common spectrum overlaps involve the K_{β} line of element Z-1 with the K_{α} line of element Z. This is called the K_{α}/K_{β} interference. Because the $K_{\alpha}:K_{\beta}$ intensity ratio for a given element usually is about 7:1, the interfering element, Z-1, must be present at large concentrations to cause a problem. Two examples of this type of spectral interference involve the presence of large concentrations of vanadium (V) when attempting to measure Cr or the presence of large concentrations of Fe when attempting to measure cobalt (Co). The V K_{α} and K_{β} energies are 4.95 and 5.43 keV, respectively, and the Cr K_{α} energy is 5.41 keV. The Fe K_{α} and K_{β} energies are 6.40 and 7.06 keV, respectively, and the Co K_{α} energy is 6.92 keV. The difference between the V K_{β} and Cr K_{α} energies is 20 eV, and the difference between the Fe K_{β} and the Co K_{α} energies is 140 eV. The resolution of the highest-resolution detectors in FPXRF instruments is 170 eV. Therefore, large amounts of V and Fe will interfere with quantitation of Cr or Co, respectively. The presence of Fe is a frequent problem because it is often found in soils at tens of thousands of parts per million (ppm).

4.7 Other interferences can arise from K/L, K/M, and L/M line overlaps, although these overlaps are less common. Examples of such overlap involve arsenic (As) K_{α} /lead (Pb) L_{α} and sulfur (S) K_{α} /Pb M_{α} . In the As/Pb case, Pb can be measured from the Pb L_{β} line, and As can be measured from either the As K_{α} or the As K_{β} line; in this way the interference can be corrected. If the As K_{β} line is used, sensitivity will be decreased by a factor of two to five times because it is a less intense line than the As K_{α} line. If the As K_{α} line is used in the presence of Pb, mathematical corrections within the instrument software can be used to subtract out the Pb interference. However, because of the limits of mathematical corrections, As concentrations cannot be efficiently calculated for samples with Pb:As ratios of 10:1 or more. This high ratio of Pb to As may result in reporting of a "nondetect" or a "less than" value (e.g., <300 ppm) for As, regardless of the actual concentration present.

No instrument can fully compensate for this interference. It is important for an operator to understand this limitation of FPXRF instruments and consult with the manufacturer of the FPXRF instrument to evaluate options to minimize this limitation. The operator's decision will be based on action levels for metals in soil established for the site, matrix effects, capabilities of the instrument, data quality objectives, and the ratio of lead to arsenic known to be present at the site. If a site is encountered that contains lead at concentrations greater than ten times the concentration of arsenic it is advisable that all critical soil samples be sent off site for confirmatory analysis using other techniques (e.g., flame atomic absorption spectrometry (FLAA), graphite furnace atomic absorption spectrometry (GFAA), inductively coupled plasma-

atomic emission spectrometry, (ICP-AES), or inductively coupled plasma-mass spectrometry, (ICP-MS)).

4.8 If SSCS are used to calibrate an FPXRF instrument, the samples collected must be representative of the site under investigation. Representative soil sampling ensures that a sample or group of samples accurately reflects the concentrations of the contaminants of concern at a given time and location. Analytical results for representative samples reflect variations in the presence and concentration ranges of contaminants throughout a site. Variables affecting sample representativeness include differences in soil type, contaminant concentration variability, sample collection and preparation variability, and analytical variability, all of which should be minimized as much as possible.

4.9 Soil physical and chemical effects may be corrected using SSCS that have been analyzed by inductively coupled plasma (ICP) or atomic absorption (AA) methods. However, a major source of error can be introduced if these samples are not representative of the site or if the analytical error is large. Another concern is the type of digestion procedure used to prepare the soil samples for the reference analysis. Analytical results for the confirmatory method will vary depending on whether a partial digestion procedure, such as Method 3050, or a total digestion procedure, such as Method 3052, is used. It is known that depending on the nature of the soil or sediment, Method 3050 will achieve differing extraction efficiencies for different analytes of interest. The confirmatory method should meet the project-specific data quality objectives (DQOs).

XRF measures the total concentration of an element; therefore, to achieve the greatest comparability of this method with the reference method (reduced bias), a total digestion procedure should be used for sample preparation. However, in the study used to generate the performance data for this method (see Table 8), the confirmatory method used was Method 3050, and the FPXRF data compared very well with regression correlation coefficients (r often exceeding 0.95, except for barium and chromium). The critical factor is that the digestion procedure and analytical reference method used should meet the DQOs of the project and match the method used for confirmation analysis.

4.10 Ambient temperature changes can affect the gain of the amplifiers producing instrument drift. Gain or drift is primarily a function of the electronics (amplifier or preamplifier) and not the detector as most instrument detectors are cooled to a constant temperature. Most FPXRF instruments have a built-in automatic gain control. If the automatic gain control is allowed to make periodic adjustments, the instrument will compensate for the influence of temperature changes on its energy scale. If the FPXRF instrument has an automatic gain control function, the operator will not have to adjust the instrument's gain unless an error message appears. If an error message appears, the operator should follow the manufacturer's procedures for troubleshooting the problem. Often, this involves performing a new energy calibration. The performance of an energy calibration check to assess drift is a quality control measure discussed in Sec. 9.2.

If the operator is instructed by the manufacturer to manually conduct a gain check because of increasing or decreasing ambient temperature, it is standard to perform a gain check after every 10 to 20 sample measurements or once an hour whichever is more frequent. It is also suggested that a gain check be performed if the temperature fluctuates more than 10° F. The operator should follow the manufacturer's recommendations for gain check frequency.

5.0 SAFETY

5.1 This method does not address all safety issues associated with its use. The user is responsible for maintaining a safe work environment and a current awareness file of OSHA regulations regarding the safe handling of the chemicals listed in this method. A reference file of material safety data sheets (MSDSs) should be available to all personnel involved in these analyses.

NOTE: No MSDS applies directly to the radiation-producing instrument because that is covered under the Nuclear Regulatory Commission (NRC) or applicable state regulations.

5.2 Proper training for the safe operation of the instrument and radiation training should be completed by the analyst prior to analysis. Radiation safety for each specific instrument can be found in the operator's manual. Protective shielding should never be removed by the analyst or any personnel other than the manufacturer. The analyst should be aware of the local state and national regulations that pertain to the use of radiation-producing equipment and radioactive materials with which compliance is required. There should be a person appointed within the organization that is solely responsible for properly instructing all personnel, maintaining inspection records, and monitoring x-ray equipment at regular intervals.

Licenses for radioactive materials are of two types, specifically: (1) a general license which is usually initiated by the manufacturer for receiving, acquiring, owning, possessing, using, and transferring radioactive material incorporated in a device or equipment, and (2) a specific license which is issued to named persons for the operation of radioactive instruments as required by local, state, or federal agencies. A copy of the radioactive material license (for specific licenses only) and leak tests should be present with the instrument at all times and available to local and national authorities upon request.

X-ray tubes do not require radioactive material licenses or leak tests, but do require approvals and licenses which vary from state to state. In addition, fail-safe x-ray warning lights should be illuminated whenever an x-ray tube is energized. Provisions listed above concerning radiation safety regulations, shielding, training, and responsible personnel apply to x-ray tubes just as to radioactive sources. In addition, a log of the times and operating conditions should be kept whenever an x-ray tube is energized. An additional hazard present with x-ray tubes is the danger of electric shock from the high voltage supply, however, if the tube is properly positioned within the instrument, this is only a negligible risk. Any instrument (x-ray tube or radioisotope based) is capable of delivering an electric shock from the basic circuitry when the system is inappropriately opened.

5.3 Radiation monitoring equipment should be used with the handling and operation of the instrument. The operator and the surrounding environment should be monitored continually for analyst exposure to radiation. Thermal luminescent detectors (TLD) in the form of badges and rings are used to monitor operator radiation exposure. The TLDs or badges should be worn in the area of maximum exposure. The maximum permissible whole-body dose from occupational exposure is 5 Roentgen Equivalent Man (REM) per year. Possible exposure pathways for radiation to enter the body are ingestion, inhaling, and absorption. The best precaution to prevent radiation exposure is distance and shielding.

6.0 EQUIPMENT AND SUPPLIES

The mention of trade names or commercial products in this manual is for illustrative purposes only, and does not constitute an EPA endorsement or exclusive recommendation for

use. The products and instrument settings cited in SW-846 methods represent those products and settings used during method development or subsequently evaluated by the Agency. Glassware, reagents, supplies, equipment, and settings other than those listed in this manual may be employed provided that method performance appropriate for the intended application has been demonstrated and documented.

6.1 FPXRF spectrometer -- An FPXRF spectrometer consists of four major components: (1) a source that provides x-rays; (2) a sample presentation device; (3) a detector that converts x-ray-generated photons emitted from the sample into measurable electronic signals; and (4) a data processing unit that contains an emission or fluorescence energy analyzer, such as an MCA, that processes the signals into an x-ray energy spectrum from which elemental concentrations in the sample may be calculated, and a data display and storage system. These components and additional, optional items, are discussed below.

6.1.1 Excitation sources -- FPXRF instruments use either a sealed radioisotope source or an x-ray tube to provide the excitation source. Many FPXRF instruments use sealed radioisotope sources to produce x-rays in order to irradiate samples. The FPXRF instrument may contain between one and three radioisotope sources. Common radioisotope sources used for analysis for metals in soils are iron Fe-55 (^{55}Fe), cadmium Cd-109 (^{109}Cd), americium Am-241 (^{241}Am), and curium Cm-244 (^{244}Cm). These sources may be contained in a probe along with a window and the detector; the probe may be connected to a data reduction and handling system by means of a flexible cable. Alternatively, the sources, window, and detector may be included in the same unit as the data reduction and handling system.

The relative strength of the radioisotope sources is measured in units of millicuries (mCi). All other components of the FPXRF system being equal, the stronger the source, the greater the sensitivity and precision of a given instrument. Radioisotope sources undergo constant decay. In fact, it is this decay process that emits the primary x-rays used to excite samples for FPXRF analysis. The decay of radioisotopes is measured in "half-lives." The half-life of a radioisotope is defined as the length of time required to reduce the radioisotopes strength or activity by half. Developers of FPXRF technologies recommend source replacement at regular intervals based on the source's half-life. This is due to the ever increasing time required for the analysis rather than a decrease in instrument performance. The characteristic x-rays emitted from each of the different sources have energies capable of exciting a certain range of analytes in a sample. Table 2 summarizes the characteristics of four common radioisotope sources.

X-ray tubes have higher radiation output, no intrinsic lifetime limit, produce constant output over their lifetime, and do not have the disposal problems of radioactive sources but are just now appearing in FPXRF instruments. An electrically-excited x-ray tube operates by bombarding an anode with electrons accelerated by a high voltage. The electrons gain an energy in electron volts equal to the accelerating voltage and can excite atomic transitions in the anode, which then produces characteristic x-rays. These characteristic x-rays are emitted through a window which contains the vacuum necessary for the electron acceleration. An important difference between x-ray tubes and radioactive sources is that the electrons which bombard the anode also produce a continuum of x-rays across a broad range of energies in addition to the characteristic x-rays. This continuum is weak compared to the characteristic x-rays but can provide substantial excitation since it covers a broad energy range. It has the undesired property of producing background in the spectrum near the analyte x-ray lines when it is scattered by the sample. For this reason a filter is often used between the x-ray tube and the sample to suppress the continuum radiation while passing the characteristic x-rays from the anode. This filter is sometimes incorporated into the window of the x-ray tube. The choice of

accelerating voltage is governed both by the anode material, since the electrons must have sufficient energy to excite the anode, which requires a voltage greater than the absorption edge of the anode material and by the instrument's ability to cool the x-ray tube. The anode is most efficiently excited by voltages 2 to 2.5 times the edge energy (most x-rays per unit power to the tube), although voltages as low as 1.5 times the absorption edge energy will work. The characteristic x-rays emitted by the anode are capable of exciting a range of elements in the sample just as with a radioactive source. Table 3 gives the recommended operating voltages and the sample elements excited for some common anodes.

6.1.2 Sample presentation device -- FPXRF instruments can be operated in two modes: in situ and intrusive. If operated in the in situ mode, the probe window is placed in direct contact with the soil surface to be analyzed. When an FPXRF instrument is operated in the intrusive mode, a soil or sediment sample must be collected, prepared, and placed in a sample cup. For FPXRF instruments operated in the intrusive mode, the probe may be rotated so that the window faces either upward or downward. A protective sample cover is placed over the window, and the sample cup is placed on top of the window inside the protective sample cover for analysis.

6.1.3 Detectors -- The detectors in the FPXRF instruments can be either solid-state detectors or gas-filled, proportional counter detectors. Common solid-state detectors include mercuric iodide (HgI_2), silicon pin diode and lithium-drifted silicon $\text{Si}(\text{Li})$. The HgI_2 detector is operated at a moderately subambient temperature controlled by a low power thermoelectric cooler. The silicon pin diode detector also is cooled via the thermoelectric Peltier effect. The $\text{Si}(\text{Li})$ detector must be cooled to at least -90°C either with liquid nitrogen or by thermoelectric cooling via the Peltier effect. Instruments with a $\text{Si}(\text{Li})$ detector have an internal liquid nitrogen dewar with a capacity of 0.5 to 1.0 L. Proportional counter detectors are rugged and lightweight, which are important features of a field portable detector. However, the resolution of a proportional counter detector is not as good as that of a solid-state detector. The energy resolution of a detector for characteristic x-rays is usually expressed in terms of full width at half-maximum (FWHM) height of the manganese K_α peak at 5.89 keV. The typical resolutions of the above mentioned detectors are as follows: HgI_2 -270 eV; silicon pin diode-250 eV; $\text{Si}(\text{Li})$ -170 eV; and gas-filled, proportional counter-750 eV.

During operation of a solid-state detector, an x-ray photon strikes a biased, solid-state crystal and loses energy in the crystal by producing electron-hole pairs. The electric charge produced is collected and provides a current pulse that is directly proportional to the energy of the x-ray photon absorbed by the crystal of the detector. A gas-filled, proportional counter detector is an ionization chamber filled with a mixture of noble and other gases. An x-ray photon entering the chamber ionizes the gas atoms. The electric charge produced is collected and provides an electric signal that is directly proportional to the energy of the x-ray photon absorbed by the gas in the detector.

6.1.4 Data processing units -- The key component in the data processing unit of an FPXRF instrument is the MCA. The MCA receives pulses from the detector and sorts them by their amplitudes (energy level). The MCA counts pulses per second to determine the height of the peak in a spectrum, which is indicative of the target analyte's concentration. The spectrum of element peaks are built on the MCA. The MCAs in FPXRF instruments have from 256 to 2,048 channels. The concentrations of target analytes are usually shown in ppm on a liquid crystal display (LCD) in the instrument. FPXRF instruments can store both spectra and from 3,000 to 5,000 sets of numerical analytical results. Most FPXRF instruments are menu-driven from software built into the

units or from PCs. Once the data-storage memory of an FPXRF unit is full or at any other time, data can be downloaded by means of an RS-232 port and cable to a P.C.

6.2 Spare battery and battery charger.

6.3 Polyethylene sample cups -- 31 to 40 mm in diameter with collar, or equivalent (appropriate for FPXRF instrument).

6.4 X-ray window film -- Mylar™, Kapton™, Spectrolene™, polypropylene, or equivalent; 2.5 to 6.0 µm thick.

6.5 Mortar and pestle -- Glass, agate, or aluminum oxide; for grinding soil and sediment samples.

6.6 Containers -- Glass or plastic to store samples.

6.7 Sieves -- 60-mesh (0.25 mm), stainless-steel, Nylon, or equivalent for preparing soil and sediment samples.

6.8 Trowels -- For smoothing soil surfaces and collecting soil samples.

6.9 Plastic bags -- Used for collection and homogenization of soil samples.

6.10 Drying oven -- Standard convection or toaster oven, for soil and sediment samples that require drying.

7.0 REAGENTS AND STANDARDS

7.1 Reagent grade chemicals must be used in all tests. Unless otherwise indicated, it is intended that all reagents conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available. Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

7.2 Pure element standards -- Each pure, single-element standard is intended to produce strong characteristic x-ray peaks of the element of interest only. Other elements present must not contribute to the fluorescence spectrum. A set of pure element standards for commonly sought analytes is supplied by the instrument manufacturer, if designated for the instrument; not all instruments require the pure element standards. The standards are used to set the region of interest (ROI) for each element. They also can be used as energy calibration and resolution check samples.

7.3 Site-specific calibration standards -- Instruments that employ fundamental parameters (FP) or similar mathematical models in minimizing matrix effects may not require SSCS. If the FP calibration model is to be optimized or if empirical calibration is necessary, then SSCSs must be collected, prepared, and analyzed.

7.3.1 The SSCS must be representative of the matrix to be analyzed by FPXRF. These samples must be well homogenized. A minimum of 10 samples spanning the concentration ranges of the analytes of interest and of the interfering elements must be obtained from the site. A sample size of 4 to 8 ounces is recommended, and standard glass sampling jars should be used.

7.3.2 Each sample should be oven-dried for 2 to 4 hr at a temperature of less than 150 °C. If mercury is to be analyzed, a separate sample portion should be dried at ambient temperature as heating may volatilize the mercury. When the sample is dry, all large, organic debris and nonrepresentative material, such as twigs, leaves, roots, insects, asphalt, and rock should be removed. The sample should be homogenized (see Sec. 7.3.3) and then a representative portion ground with a mortar and pestle or other mechanical means, prior to passing through a 60-mesh sieve. Only the coarse rock fraction should remain on the screen.

7.3.3 The sample should be homogenized by using a riffle splitter or by placing 150 to 200 g of the dried, sieved sample on a piece of kraft or butcher paper about 1.5 by 1.5 feet in size. Each corner of the paper should be lifted alternately, rolling the soil over on itself and toward the opposite corner. The soil should be rolled on itself 20 times. Approximately 5 g of the sample should then be removed and placed in a sample cup for FPXRF analysis. The rest of the prepared sample should be sent off site for ICP or AA analysis. The method used for confirmatory analysis should meet the data quality objectives of the project.

7.4 Blank samples -- The blank samples should be from a "clean" quartz or silicon dioxide matrix that is free of any analytes at concentrations above the established lower limit of detection. These samples are used to monitor for cross-contamination and laboratory-induced contaminants or interferences.

7.5 Standard reference materials -- Standard reference materials (SRMs) are standards containing certified amounts of metals in soil or sediment. These standards are used for accuracy and performance checks of FPXRF analyses. SRMs can be obtained from the National Institute of Standards and Technology (NIST), the U.S. Geological Survey (USGS), the Canadian National Research Council, and the national bureau of standards in foreign nations. Pertinent NIST SRMs for FPXRF analysis include 2704, Buffalo River Sediment; 2709, San Joaquin Soil; and 2710 and 2711, Montana Soil. These SRMs contain soil or sediment from actual sites that has been analyzed using independent inorganic analytical methods by many different laboratories. When these SRMs are unavailable, alternate standards may be used (e.g., NIST 2702).

8.0 SAMPLE COLLECTION, PRESERVATION, AND STORAGE

Sample handling and preservation procedures used in FPXRF analyses should follow the guidelines in Chapter Three, "Inorganic Analytes."

9.0 QUALITY CONTROL

9.1 Follow the manufacturer's instructions for the quality control procedures specific to use of the testing product. Refer to Chapter One for additional guidance on quality assurance (QA) and quality control (QC) protocols. Any effort involving the collection of analytical data should include development of a structured and systematic planning document, such as a Quality Assurance Project Plan (QAPP) or a Sampling and Analysis Plan (SAP), which translates project objectives and specifications into directions for those that will implement the project and assess the results.

9.2 Energy calibration check -- To determine whether an FPXRF instrument is operating within resolution and stability tolerances, an energy calibration check should be run. The energy calibration check determines whether the characteristic x-ray lines are shifting,

which would indicate drift within the instrument. As discussed in Sec. 4.10, this check also serves as a gain check in the event that ambient temperatures are fluctuating greatly (more than 10 °F).

9.2.1 The energy calibration check should be run at a frequency consistent with manufacturer's recommendations. Generally, this would be at the beginning of each working day, after the batteries are changed, or the instrument is shut off, at the end of each working day, and at any other time when the instrument operator believes that drift is occurring during analysis. A pure element such as iron, manganese, copper, or lead is often used for the energy calibration check. A manufacturer-recommended count time per source should be used for the check.

9.2.2 The instrument manufacturer's manual specifies the channel or kiloelectron volt level at which a pure element peak should appear and the expected intensity of the peak. The intensity and channel number of the pure element as measured using the source should be checked and compared to the manufacturer's recommendation. If the energy calibration check does not meet the manufacturer's criteria, then the pure element sample should be repositioned and reanalyzed. If the criteria are still not met, then an energy calibration should be performed as described in the manufacturer's manual. With some FPXRF instruments, once a spectrum is acquired from the energy calibration check, the peak can be optimized and realigned to the manufacturer's specifications using their software.

9.3 Blank samples -- Two types of blank samples should be analyzed for FPXRF analysis, specifically, instrument blanks and method blanks.

9.3.1 An instrument blank is used to verify that no contamination exists in the spectrometer or on the probe window. The instrument blank can be silicon dioxide, a polytetrafluoroethylene (PTFE) block, a quartz block, "clean" sand, or lithium carbonate. This instrument blank should be analyzed on each working day before and after analyses are conducted and once per every twenty samples. An instrument blank should also be analyzed whenever contamination is suspected by the analyst. The frequency of analysis will vary with the data quality objectives of the project. A manufacturer-recommended count time per source should be used for the blank analysis. No element concentrations above the established lower limit of detection should be found in the instrument blank. If concentrations exceed these limits, then the probe window and the check sample should be checked for contamination. If contamination is not a problem, then the instrument must be "zeroed" by following the manufacturer's instructions.

9.3.2 A method blank is used to monitor for laboratory-induced contaminants or interferences. The method blank can be "clean" silica sand or lithium carbonate that undergoes the same preparation procedure as the samples. A method blank must be analyzed at least daily. The frequency of analysis will depend on the data quality objectives of the project. If the method blank does not contain the target analyte at a level that interferes with the project-specific data quality objectives then the method blank would be considered acceptable. In the absence of project-specific data quality objectives, if the blank is less than the lowest level of detection or less than 10% of the lowest sample concentration for the analyte, whichever is greater, then the method blank would be considered acceptable. If the method blank cannot be considered acceptable, the cause of the problem must be identified, and all samples analyzed with the method blank must be reanalyzed.

9.4 Calibration verification checks -- A calibration verification check sample is used to check the accuracy of the instrument and to assess the stability and consistency of the analysis for the analytes of interest. A check sample should be analyzed at the beginning of each working day, during active sample analyses, and at the end of each working day. The frequency of calibration checks during active analysis will depend on the data quality objectives of the project. The check sample should be a well characterized soil sample from the site that is representative of site samples in terms of particle size and degree of homogeneity and that contains contaminants at concentrations near the action levels. If a site-specific sample is not available, then an NIST or other SRM that contains the analytes of interest can be used to verify the accuracy of the instrument. The measured value for each target analyte should be within ± 20 percent (%D) of the true value for the calibration verification check to be acceptable. If a measured value falls outside this range, then the check sample should be reanalyzed. If the value continues to fall outside the acceptance range, the instrument should be recalibrated, and the batch of samples analyzed before the unacceptable calibration verification check must be reanalyzed.

9.5 Precision measurements -- The precision of the method is monitored by analyzing a sample with low, moderate, or high concentrations of target analytes. The frequency of precision measurements will depend on the data quality objectives for the data. A minimum of one precision sample should be run per day. Each precision sample should be analyzed 7 times in replicate. It is recommended that precision measurements be obtained for samples with varying concentration ranges to assess the effect of concentration on method precision. Determining method precision for analytes at concentrations near the site action levels can be extremely important if the FPXRF results are to be used in an enforcement action; therefore, selection of at least one sample with target analyte concentrations at or near the site action levels or levels of concern is recommended. A precision sample is analyzed by the instrument for the same field analysis time as used for other project samples. The relative standard deviation (RSD) of the sample mean is used to assess method precision. For FPXRF data to be considered adequately precise, the RSD should not be greater than 20 percent with the exception of chromium. RSD values for chromium should not be greater than 30 percent. If both in situ and intrusive analytical techniques are used during the course of one day, it is recommended that separate precision calculations be performed for each analysis type.

The equation for calculating RSD is as follows:

$$\text{RSD} = (\text{SD}/\text{Mean Concentration}) \times 100$$

where:

RSD	=	Relative standard deviation for the precision measurement for the analyte
SD	=	Standard deviation of the concentration for the analyte
Mean concentration	=	Mean concentration for the analyte

The precision or reproducibility of a measurement will improve with increasing count time, however, increasing the count time by a factor of 4 will provide only 2 times better precision, so there is a point of diminishing return. Increasing the count time also improves the sensitivity, but decreases sample throughput.

9.6 The lower limits of detection should be established from actual measured performance based on spike recoveries in the matrix of concern or from acceptable method performance on a certified reference material of the appropriate matrix and within the appropriate calibration range for the application. This is considered the best estimate of the true method sensitivity as opposed to a statistical determination based on the standard deviation of

replicate analyses of a low-concentration sample. While the statistical approach demonstrates the potential data variability for a given sample matrix at one point in time, it does not represent what can be detected or most importantly the lowest concentration that can be calibrated. For this reason the sensitivity should be established as the lowest point of detection based on acceptable target analyte recovery in the desired sample matrix.

9.7 Confirmatory samples -- The comparability of the FPXRF analysis is determined by submitting FPXRF-analyzed samples for analysis at a laboratory. The method of confirmatory analysis must meet the project and XRF measurement data quality objectives. The confirmatory samples must be splits of the well homogenized sample material. In some cases the prepared sample cups can be submitted. A minimum of 1 sample for each 20 FPXRF-analyzed samples should be submitted for confirmatory analysis. This frequency will depend on project-specific data quality objectives. The confirmatory analyses can also be used to verify the quality of the FPXRF data. The confirmatory samples should be selected from the lower, middle, and upper range of concentrations measured by the FPXRF. They should also include samples with analyte concentrations at or near the site action levels. The results of the confirmatory analysis and FPXRF analyses should be evaluated with a least squares linear regression analysis. If the measured concentrations span more than one order of magnitude, the data should be log-transformed to standardize variance which is proportional to the magnitude of measurement. The correlation coefficient (r) for the results should be 0.7 or greater for the FPXRF data to be considered screening level data. If the r is 0.9 or greater and inferential statistics indicate the FPXRF data and the confirmatory data are statistically equivalent at a 99 percent confidence level, the data could potentially meet definitive level data criteria.

10.0 CALIBRATION AND STANDARDIZATION

10.1 Instrument calibration -- Instrument calibration procedures vary among FPXRF instruments. Users of this method should follow the calibration procedures outlined in the operator's manual for each specific FPXRF instrument. Generally, however, three types of calibration procedures exist for FPXRF instruments, namely: FP calibration, empirical calibration, and the Compton peak ratio or normalization method. These three types of calibration are discussed below.

10.2 Fundamental parameters calibration -- FP calibration procedures are extremely variable. An FP calibration provides the analyst with a "standardless" calibration. The advantages of FP calibrations over empirical calibrations include the following:

- No previously collected site-specific samples are necessary, although site-specific samples with confirmed and validated analytical results for all elements present could be used.
- Cost is reduced because fewer confirmatory laboratory results or calibration standards are necessary.

However, the analyst should be aware of the limitations imposed on FP calibration by particle size and matrix effects. These limitations can be minimized by adhering to the preparation procedure described in Sec. 7.3. The two FP calibration processes discussed below are based on an effective energy FP routine and a back scatter with FP (BFP) routine. Each FPXRF FP calibration process is based on a different iterative algorithmic method. The calibration procedure for each routine is explained in detail in the manufacturer's user manual for each FPXRF instrument; in addition, training courses are offered for each instrument.

10.2.1 Effective energy FP calibration -- The effective energy FP calibration is performed by the manufacturer before an instrument is sent to the analyst. Although SSCS can be used, the calibration relies on pure element standards or SRMs such as those obtained from NIST for the FP calibration. The effective energy routine relies on the spectrometer response to pure elements and FP iterative algorithms to compensate for various matrix effects.

Alpha coefficients are calculated using a variation of the Sherman equation, which calculates theoretical intensities from the measurement of pure element samples. These coefficients indicate the quantitative effect of each matrix element on an analyte's measured x-ray intensity. Next, the Lachance Traill algorithm is solved as a set of simultaneous equations based on the theoretical intensities. The alpha coefficients are then downloaded into the specific instrument.

The working effective energy FP calibration curve must be verified before sample analysis begins on each working day, after every 20 samples are analyzed, and at the end of sampling. This verification is performed by analyzing either an NIST SRM or an SSCS that is representative of the site-specific samples. This SRM or SSCS serves as a calibration check. A manufacturer-recommended count time per source should be used for the calibration check. The analyst must then adjust the y-intercept and slope of the calibration curve to best fit the known concentrations of target analytes in the SRM or SSCS.

A percent difference (%D) is then calculated for each target analyte. The %D should be within ± 20 percent of the certified value for each analyte. If the %D falls outside this acceptance range, then the calibration curve should be adjusted by varying the slope of the line or the y-intercept value for the analyte. The SRM or SSCS is reanalyzed until the %D falls within ± 20 percent. The group of 20 samples analyzed before an out-of-control calibration check should be reanalyzed.

The equation to calibrate %D is as follows:

$$\%D = ((C_s - C_k) / C_k) \times 100$$

where:

%D = Percent difference

C_k = Certified concentration of standard sample

C_s = Measured concentration of standard sample

10.2.2 BFP calibration -- BFP calibration relies on the ability of the liquid nitrogen-cooled, Si(Li) solid-state detector to separate the coherent (Compton) and incoherent (Rayleigh) backscatter peaks of primary radiation. These peak intensities are known to be a function of sample composition, and the ratio of the Compton to Rayleigh peak is a function of the mass absorption of the sample. The calibration procedure is explained in detail in the instrument manufacturer's manual. Following is a general description of the BFP calibration procedure.

The concentrations of all detected and quantified elements are entered into the computer software system. Certified element results for an NIST SRM or confirmed and validated results for an SSCS can be used. In addition, the concentrations of oxygen and silicon must be entered; these two concentrations are not found in standard metals analyses. The manufacturer provides silicon and oxygen concentrations for typical soil types. Pure element standards are then analyzed using a manufacturer-recommended

count time per source. The results are used to calculate correction factors in order to adjust for spectrum overlap of elements.

The working BFP calibration curve must be verified before sample analysis begins on each working day, after every 20 samples are analyzed, and at the end of the analysis. This verification is performed by analyzing either an NIST SRM or an SSCS that is representative of the site-specific samples. This SRM or SSCS serves as a calibration check. The standard sample is analyzed using a manufacturer-recommended count time per source to check the calibration curve. The analyst must then adjust the y-intercept and slope of the calibration curve to best fit the known concentrations of target analytes in the SRM or SSCS.

A %D is then calculated for each target analyte. The %D should fall within ± 20 percent of the certified value for each analyte. If the %D falls outside this acceptance range, then the calibration curve should be adjusted by varying the slope of the line the y-intercept value for the analyte. The standard sample is reanalyzed until the %D falls within ± 20 percent. The group of 20 samples analyzed before an out-of-control calibration check should be reanalyzed.

10.3 Empirical calibration -- An empirical calibration can be performed with SSCS, site-typical standards, or standards prepared from metal oxides. A discussion of SSCS is included in Sec. 7.3; if no previously characterized samples exist for a specific site, site-typical standards can be used. Site-typical standards may be selected from commercially available characterized soils or from SSCS prepared for another site. The site-typical standards should closely approximate the site's soil matrix with respect to particle size distribution, mineralogy, and contaminant analytes. If neither SSCS nor site-typical standards are available, it is possible to make gravimetric standards by adding metal oxides to a "clean" sand or silicon dioxide matrix that simulates soil. Metal oxides can be purchased from various chemical vendors. If standards are made on site, a balance capable of weighing items to at least two decimal places is necessary. Concentrated ICP or AA standard solutions can also be used to make standards. These solutions are available in concentrations of 10,000 parts per million, thus only small volumes have to be added to the soil.

An empirical calibration using SSCS involves analysis of SSCS by the FPXRF instrument and by a conventional analytical method such as ICP or AA. A total acid digestion procedure should be used by the laboratory for sample preparation. Generally, a minimum of 10 and a maximum of 30 well characterized SSCS, site-typical standards, or prepared metal oxide standards are necessary to perform an adequate empirical calibration. The exact number of standards depends on the number of analytes of interest and interfering elements. Theoretically, an empirical calibration with SSCS should provide the most accurate data for a site because the calibration compensates for site-specific matrix effects.

The first step in an empirical calibration is to analyze the pure element standards for the elements of interest. This enables the instrument to set channel limits for each element for spectral deconvolution. Next the SSCS, site-typical standards, or prepared metal oxide standards are analyzed using a count time of 200 seconds per source or a count time recommended by the manufacturer. This will produce a spectrum and net intensity of each analyte in each standard. The analyte concentrations for each standard are then entered into the instrument software; these concentrations are those obtained from the laboratory, the certified results, or the gravimetrically determined concentrations of the prepared standards. This gives the instrument analyte values to regress against corresponding intensities during the modeling stage. The regression equation correlates the concentrations of an analyte with its net intensity.

The calibration equation is developed using a least squares fit regression analysis. After the regression terms to be used in the equation are defined, a mathematical equation can be developed to calculate the analyte concentration in an unknown sample. In some FPXRF instruments, the software of the instrument calculates the regression equation. The software uses calculated intercept and slope values to form a multiterm equation. In conjunction with the software in the instrument, the operator can adjust the multiterm equation to minimize interelement interferences and optimize the intensity calibration curve.

It is possible to define up to six linear or nonlinear terms in the regression equation. Terms can be added and deleted to optimize the equation. The goal is to produce an equation with the smallest regression error and the highest correlation coefficient. These values are automatically computed by the software as the regression terms are added, deleted, or modified. It is also possible to delete data points from the regression line if these points are significant outliers or if they are heavily weighing the data. Once the regression equation has been selected for an analyte, the equation can be entered into the software for quantitation of analytes in subsequent samples. For an empirical calibration to be acceptable, the regression equation for a specific analyte should have a correlation coefficient of 0.98 or greater or meet the DQOs of the project.

In an empirical calibration, one must apply the DQOs of the project and ascertain critical or action levels for the analytes of interest. It is within these concentration ranges or around these action levels that the FPXRF instrument should be calibrated most accurately. It may not be possible to develop a good regression equation over several orders of analyte concentration.

10.4 Compton normalization method -- The Compton normalization method is based on analysis of a single, certified standard and normalization for the Compton peak. The Compton peak is produced from incoherent backscattering of x-ray radiation from the excitation source and is present in the spectrum of every sample. The Compton peak intensity changes with differing matrices. Generally, matrices dominated by lighter elements produce a larger Compton peak, and those dominated by heavier elements produce a smaller Compton peak. Normalizing to the Compton peak can reduce problems with varying matrix effects among samples. Compton normalization is similar to the use of internal standards in organics analysis. The Compton normalization method may not be effective when analyte concentrations exceed a few percent.

The certified standard used for this type of calibration could be an NIST SRM such as 2710 or 2711. The SRM must be a matrix similar to the samples and must contain the analytes of interests at concentrations near those expected in the samples. First, a response factor has to be determined for each analyte. This factor is calculated by dividing the net peak intensity by the analyte concentration. The net peak intensity is gross intensity corrected for baseline reading. Concentrations of analytes in samples are then determined by multiplying the baseline corrected analyte signal intensity by the normalization factor and by the response factor. The normalization factor is the quotient of the baseline corrected Compton K_{α} peak intensity of the SRM divided by that of the samples. Depending on the FPXRF instrument used, these calculations may be done manually or by the instrument software.

11.0 PROCEDURE

11.1 Operation of the various FPXRF instruments will vary according to the manufacturers' protocols. Before operating any FPXRF instrument, one should consult the manufacturer's manual. Most manufacturers recommend that their instruments be allowed to warm up for 15 to 30 minutes before analysis of samples. This will help alleviate drift or energy calibration problems later during analysis.

11.2 Each FPXRF instrument should be operated according to the manufacturer's recommendations. There are two modes in which FPXRF instruments can be operated: in situ and intrusive. The in situ mode involves analysis of an undisturbed soil sediment or sample. Intrusive analysis involves collection and preparation of a soil or sediment sample before analysis. Some FPXRF instruments can operate in both modes of analysis, while others are designed to operate in only one mode. The two modes of analysis are discussed below.

11.3 For in situ analysis, remove any large or nonrepresentative debris from the soil surface before analysis. This debris includes rocks, pebbles, leaves, vegetation, roots, and concrete. Also, the soil surface must be as smooth as possible so that the probe window will have good contact with the surface. This may require some leveling of the surface with a stainless-steel trowel. During the study conducted to provide example performance data for this method, this modest amount of sample preparation was found to take less than 5 min per sample location. The last requirement is that the soil or sediment not be saturated with water. Manufacturers state that their FPXRF instruments will perform adequately for soils with moisture contents of 5 to 20 percent but will not perform well for saturated soils, especially if ponded water exists on the surface. Another recommended technique for in situ analysis is to tamp the soil to increase soil density and compactness for better repeatability and representativeness. This condition is especially important for heavy element analysis, such as barium. Source count times for in situ analysis usually range from 30 to 120 seconds, but source count times will vary among instruments and depending on the desired method sensitivity. Due to the heterogeneous nature of the soil sample, in situ analysis can provide only "screening" type data.

11.4 For intrusive analysis of surface or sediment, it is recommended that a sample be collected from a 4- by 4-inch square that is 1 inch deep. This will produce a soil sample of approximately 375 g or 250 cm³, which is enough soil to fill an 8-ounce jar. However, the exact dimensions and sample depth should take into consideration the heterogeneous deposition of contaminants and will ultimately depend on the desired project-specific data quality objectives. The sample should be homogenized, dried, and ground before analysis. The sample can be homogenized before or after drying. The homogenization technique to be used after drying is discussed in Sec. 4.2. If the sample is homogenized before drying, it should be thoroughly mixed in a beaker or similar container, or if the sample is moist and has a high clay content, it can be kneaded in a plastic bag. One way to monitor homogenization when the sample is kneaded in a plastic bag is to add sodium fluorescein dye to the sample. After the moist sample has been homogenized, it is examined under an ultraviolet light to assess the distribution of sodium fluorescein throughout the sample. If the fluorescent dye is evenly distributed in the sample, homogenization is considered complete; if the dye is not evenly distributed, mixing should continue until the sample has been thoroughly homogenized. During the study conducted to provide data for this method, the time necessary for homogenization procedure using the fluorescein dye ranged from 3 to 5 min per sample. As demonstrated in Secs. 13.5 and 13.7, homogenization has the greatest impact on the reduction of sampling variability. It produces little or no contamination. Often, the direct analysis through the plastic bag is possible without the more labor intensive steps of drying, grinding, and sieving given in Secs. 11.5 and 11.6. Of course, to achieve the best data quality possible all four steps should be followed.

11.5 Once the soil or sediment sample has been homogenized, it should be dried. This can be accomplished with a toaster oven or convection oven. A small aliquot of the sample (20 to 50 g) is placed in a suitable container for drying. The sample should be dried for 2 to 4 hr in the convection or toaster oven at a temperature not greater than 150 °C. Samples may also be air dried under ambient temperature conditions using a 10- to 20-g portion. Regardless of what drying mechanism is used, the drying process is considered complete when a constant sample weight can be obtained. Care should be taken to avoid sample cross-contamination and these measures can be evaluated by including an appropriate method blank sample along with any sample preparation process.

CAUTION: Microwave drying is not a recommended procedure. Field studies have shown that microwave drying can increase variability between the FPXRF data and confirmatory analysis. High levels of metals in a sample can cause arcing in the microwave oven, and sometimes slag forms in the sample. Microwave oven drying can also melt plastic containers used to hold the sample.

11.6 The homogenized dried sample material should be ground with a mortar and pestle and passed through a 60-mesh sieve to achieve a uniform particle size. Sample grinding should continue until at least 90 percent of the original sample passes through the sieve. The grinding step normally takes an average of 10 min per sample. An aliquot of the sieved sample should then be placed in a 31.0-mm polyethylene sample cup (or equivalent) for analysis. The sample cup should be one-half to three-quarters full at a minimum. The sample cup should be covered with a 2.5 µm Mylar (or equivalent) film for analysis. The rest of the soil sample should be placed in a jar, labeled, and archived for possible confirmation analysis. All equipment including the mortar, pestle, and sieves must be thoroughly cleaned so that any cross-contamination is below the established lower limit of detection of the procedure or DQOs of the analysis. If all recommended sample preparation steps are followed, there is a high probability the desired laboratory data quality may be obtained.

12.0 DATA ANALYSIS AND CALCULATIONS

Most FPXRF instruments have software capable of storing all analytical results and spectra. The results are displayed in ppm and can be downloaded to a personal computer, which can be used to provide a hard copy printout. Individual measurements that are smaller than three times their associated SD should not be used for quantitation. See the manufacturer's instructions regarding data analysis and calculations.

13.0 METHOD PERFORMANCE

13.1 Performance data and related information are provided in SW-846 methods only as examples and guidance. The data do not represent required performance criteria for users of the methods. Instead, performance criteria should be developed on a project-specific basis, and the laboratory should establish in-house QC performance criteria for the application of this method. These performance data are not intended to be and must not be used as absolute QC acceptance criteria for purposes of laboratory accreditation.

13.2 The sections to follow discuss three performance evaluation factors; namely, precision, accuracy, and comparability. The example data presented in Tables 4 through 8 were generated from results obtained from six FPXRF instruments (see Sec. 13.3). The soil samples analyzed by the six FPXRF instruments were collected from two sites in the United States. The soil samples contained several of the target analytes at concentrations ranging from "nondetect" to tens of thousands of mg/kg. These data are provided for guidance purposes only.

13.3 The six FPXRF instruments included the TN 9000 and TN Lead Analyzer manufactured by TN Spectrace; the X-MET 920 with a SiLi detector and X-MET 920 with a gas-filled proportional detector manufactured by Metorex, Inc.; the XL Spectrum Analyzer manufactured by Niton; and the MAP Spectrum Analyzer manufactured by Scitec. The TN 9000 and TN Lead Analyzer both have a Hg_L detector. The TN 9000 utilized an Fe-55, Cd-109, and Am-241 source. The TN Lead Analyzer had only a Cd-109 source. The X-Met 920 with the SiLi detector had a Cd-109 and Am-241 source. The X-MET 920 with the gas-filled proportional detector had only a Cd-109 source. The XL Spectrum Analyzer utilized a silicon pin-diode

detector and a Cd-109 source. The MAP Spectrum Analyzer utilized a solid-state silicon detector and a Cd-109 source.

13.4 All example data presented in Tables 4 through 8 were generated using the following calibrations and source count times. The TN 9000 and TN Lead Analyzer were calibrated using fundamental parameters using NIST SRM 2710 as a calibration check sample. The TN 9000 was operated using 100, 60, and 60 second count times for the Cd-109, Fe-55, and Am-241 sources, respectively. The TN Lead analyzer was operated using a 60 second count time for the Cd-109 source. The X-MET 920 with the Si(Li) detector was calibrated using fundamental parameters and one well characterized site-specific soil standard as a calibration check. It used 140 and 100 second count times for the Cd-109 and Am-241 sources, respectively. The X-MET 920 with the gas-filled proportional detector was calibrated empirically using between 10 and 20 well characterized site-specific soil standards. It used 120 second times for the Cd-109 source. The XL Spectrum Analyzer utilized NIST SRM 2710 for calibration and the Compton peak normalization procedure for quantitation based on 60 second count times for the Cd-109 source. The MAP Spectrum Analyzer was internally calibrated by the manufacturer. The calibration was checked using a well-characterized site-specific soil standard. It used 240 second times for the Cd-109 source.

13.5 Precision measurements -- The example precision data are presented in Table 4. These data are provided for guidance purposes only. Each of the six FPXRF instruments performed 10 replicate measurements on 12 soil samples that had analyte concentrations ranging from "nondetects" to thousands of mg/kg. Each of the 12 soil samples underwent 4 different preparation techniques from in situ (no preparation) to dried and ground in a sample cup. Therefore, there were 48 precision data points for five of the instruments and 24 precision points for the MAP Spectrum Analyzer. The replicate measurements were taken using the source count times discussed at the beginning of this section.

For each detectable analyte in each precision sample a mean concentration, standard deviation, and RSD was calculated for each analyte. The data presented in Table 4 is an average RSD for the precision samples that had analyte concentrations at 5 to 10 times the lower limit of detection for that analyte for each instrument. Some analytes such as mercury, selenium, silver, and thorium were not detected in any of the precision samples so these analytes are not listed in Table 4. Some analytes such as cadmium, nickel, and tin were only detected at concentrations near the lower limit of detection so that an RSD value calculated at 5 to 10 times this limit was not possible.

One FPXRF instrument collected replicate measurements on an additional nine soil samples to provide a better assessment of the effect of sample preparation on precision. Table 5 shows these results. These data are provided for guidance purposes only. The additional nine soil samples were comprised of three from each texture and had analyte concentrations ranging from near the lower limit of detection for the FPXRF analyzer to thousands of mg/kg. The FPXRF analyzer only collected replicate measurements from three of the preparation methods; no measurements were collected from the in situ homogenized samples. The FPXRF analyzer conducted five replicate measurements of the in situ field samples by taking measurements at five different points within the 4-inch by 4-inch sample square. Ten replicate measurements were collected for both the intrusive undried and unground and intrusive dried and ground samples contained in cups. The cups were shaken between each replicate measurement.

Table 5 shows that the precision dramatically improved from the in situ to the intrusive measurements. In general there was a slight improvement in precision when the sample was dried and ground. Two factors caused the precision for the in situ measurements to be poorer. The major factor is soil heterogeneity. By moving the probe within the 4-inch by 4-inch square,

measurements of different soil samples were actually taking place within the square. Table 5 illustrates the dominant effect of soil heterogeneity. It overwhelmed instrument precision when the FPXRF analyzer was used in this mode. The second factor that caused the RSD values to be higher for the in situ measurements is the fact that only five instead of ten replicates were taken. A lesser number of measurements caused the standard deviation to be larger which in turn elevated the RSD values.

13.6 Accuracy measurements -- Five of the FPXRF instruments (not including the MAP Spectrum Analyzer) analyzed 18 SRMs using the source count times and calibration methods given at the beginning of this section. The 18 SRMs included 9 soil SRMs, 4 stream or river sediment SRMs, 2 sludge SRMs, and 3 ash SRMs. Each of the SRMs contained known concentrations of certain target analytes. A percent recovery was calculated for each analyte in each SRM for each FPXRF instrument. Table 6 presents a summary of this data. With the exception of cadmium, chromium, and nickel, the values presented in Table 6 were generated from the 13 soil and sediment SRMs only. The 2 sludge and 3 ash SRMs were included for cadmium, chromium, and nickel because of the low or nondetectable concentrations of these three analytes in the soil and sediment SRMs.

Only 12 analytes are presented in Table 6. These are the analytes that are of environmental concern and provided a significant number of detections in the SRMs for an accuracy assessment. No data is presented for the X-MET 920 with the gas-filled proportional detector. This FPXRF instrument was calibrated empirically using site-specific soil samples. The percent recovery values from this instrument were very sporadic and the data did not lend itself to presentation in Table 6.

Table 7 provides a more detailed summary of accuracy data for one particular FPXRF instrument (TN 9000) for the 9 soil SRMs and 4 sediment SRMs. These data are provided for guidance purposes only. Table 7 shows the certified value, measured value, and percent recovery for five analytes. These analytes were chosen because they are of environmental concern and were most prevalently certified for in the SRM and detected by the FPXRF instrument. The first nine SRMs are soil and the last 4 SRMs are sediment. Percent recoveries for the four NIST SRMs were often between 90 and 110 percent for all analytes.

13.7 Comparability -- Comparability refers to the confidence with which one data set can be compared to another. In this case, FPXRF data generated from a large study of six FPXRF instruments was compared to SW-846 Methods 3050 and 6010 which are the standard soil extraction for metals and analysis by inductively coupled plasma. An evaluation of comparability was conducted by using linear regression analysis. Three factors were determined using the linear regression. These factors were the y-intercept, the slope of the line, and the coefficient of determination (r^2).

As part of the comparability assessment, the effects of soil type and preparation methods were studied. Three soil types (textures) and four preparation methods were examined during the study. The preparation methods evaluated the cumulative effect of particle size, moisture, and homogenization on comparability. Due to the large volume of data produced during this study, linear regression data for six analytes from only one FPXRF instrument is presented in Table 8. Similar trends in the data were seen for all instruments. These data are provided for guidance purposes only.

Table 8 shows the regression parameters for the whole data set, broken out by soil type, and by preparation method. These data are provided for guidance purposes only. The soil types are as follows: soil 1--sand; soil 2--loam; and soil 3--silty clay. The preparation methods are as follows: preparation 1--in situ in the field; preparation 2--intrusive, sample collected and homogenized; preparation 3--intrusive, with sample in a sample cup but sample still wet and not

ground; and preparation 4—intrusive, with sample dried, ground, passed through a 40-mesh sieve, and placed in sample cup.

For arsenic, copper, lead, and zinc, the comparability to the confirmatory laboratory was excellent with r^2 values ranging from 0.80 to 0.99 for all six FPXRF instruments. The slopes of the regression lines for arsenic, copper, lead, and zinc, were generally between 0.90 and 1.00 indicating the data would need to be corrected very little or not at all to match the confirmatory laboratory data. The r^2 values and slopes of the regression lines for barium and chromium were not as good as for the other for analytes, indicating the data would have to be corrected to match the confirmatory laboratory.

Table 8 demonstrates that there was little effect of soil type on the regression parameters for any of the six analytes. The only exceptions were for barium in soil 1 and copper in soil 3. In both of these cases, however, it is actually a concentration effect and not a soil effect causing the poorer comparability. All barium and copper concentrations in soil 1 and 3, respectively, were less than 350 mg/kg.

Table 8 shows there was a preparation effect on the regression parameters for all six analytes. With the exception of chromium, the regression parameters were primarily improved going from preparation 1 to preparation 2. In this step, the sample was removed from the soil surface, all large debris was removed, and the sample was thoroughly homogenized. The additional two preparation methods did little to improve the regression parameters. This data indicates that homogenization is the most critical factor when comparing the results. It is essential that the sample sent to the confirmatory laboratory match the FPXRF sample as closely as possible.

Sec. 11.0 of this method discusses the time necessary for each of the sample preparation techniques. Based on the data quality objectives for the project, an analyst must decide if it is worth the extra time necessary to dry and grind the sample for small improvements in comparability. Homogenization requires 3 to 5 min. Drying the sample requires one to two hours. Grinding and sieving requires another 10 to 15 min per sample. Lastly, when grinding and sieving is conducted, time has to be allotted to decontaminate the mortars, pestles, and sieves. Drying and grinding the samples and decontamination procedures will often dictate that an extra person be on site so that the analyst can keep up with the sample collection crew. The cost of requiring an extra person on site to prepare samples must be balanced with the gain in data quality and sample throughput.

13.8 The following documents may provide additional guidance and insight on this method and technique:

13.8.1 A. D. Hewitt, "Screening for Metals by X-ray Fluorescence Spectrometry/Response Factor/Compton K_{α} Peak Normalization Analysis," American Environmental Laboratory, pp 24-32, 1994.

13.8.2 S. Piorek and J. R. Pasmore, "Standardless, In Situ Analysis of Metallic Contaminants in the Natural Environment With a PC-Based, High Resolution Portable X-Ray Analyzer," Third International Symposium on Field Screening Methods for Hazardous Waste and Toxic Chemicals, Las Vegas, Nevada, February 24-26, 1993, Vol 2, pp 1135-1151, 1993.

13.8.3 S. Shefsky, "Sample Handling Strategies for Accurate Lead-in-soil Measurements in the Field and Laboratory," *International Symposium of Field Screening Methods for Hazardous Waste and Toxic Chemicals*, Las Vegas, NV, January 29-31, 1997.

14.0 POLLUTION PREVENTION

14.1 Pollution prevention encompasses any technique that reduces or eliminates the quantity and/or toxicity of waste at the point of generation. Numerous opportunities for pollution prevention exist in laboratory operation. The EPA has established a preferred hierarchy of environmental management techniques that places pollution prevention as the management option of first choice. Whenever feasible, laboratory personnel should use pollution prevention techniques to address their waste generation. When wastes cannot be feasibly reduced at the source, the Agency recommends recycling as the next best option.

14.2 For information about pollution prevention that may be applicable to laboratories and research institutions consult *Less is Better: Laboratory Chemical Management for Waste Reduction* available from the American Chemical Society's Department of Government Relations and Science Policy, 1155 16th St., N.W. Washington, D.C. 20036, <http://www.acs.org>.

15.0 WASTE MANAGEMENT

The Environmental Protection Agency requires that laboratory waste management practices be conducted consistent with all applicable rules and regulations. The Agency urges laboratories to protect the air, water, and land by minimizing and controlling all releases from hoods and bench operations, complying with the letter and spirit of any sewer discharge permits and regulations, and by complying with all solid and hazardous waste regulations, particularly the hazardous waste identification rules and land disposal restrictions. For further information on waste management, consult *The Waste Management Manual for Laboratory Personnel* available from the American Chemical Society at the address listed in Sec. 14.2.

16.0 REFERENCES

1. Metorex, X-MET 920 User's Manual.
2. Spectrace Instruments, "Energy Dispersive X-ray Fluorescence Spectrometry: An Introduction," 1994.
3. TN Spectrace, Spectrace 9000 Field Portable/Benchtop XRF Training and Applications Manual.
4. Unpublished SITE data, received from PRC Environment Management, Inc.

17.0 TABLES, DIAGRAMS, FLOWCHARTS, AND VALIDATION DATA

The following pages contain the tables referenced by this method. A flow diagram of the procedure follows the tables.

TABLE 1

EXAMPLE INTERFERENCE FREE LOWER LIMITS OF DETECTION

Analyte	Chemical Abstract Series Number	Lower Limit of Detection in Quartz Sand (milligrams per kilogram)
Antimony (Sb)	7440-36-0	40
Arsenic (As)	7440-38-0	40
Barium (Ba)	7440-39-3	20
Cadmium (Cd)	7440-43-9	100
Calcium (Ca)	7440-70-2	70
Chromium (Cr)	7440-47-3	150
Cobalt (Co)	7440-48-4	60
Copper (Cu)	7440-50-8	50
Iron (Fe)	7439-89-6	60
Lead (Pb)	7439-92-1	20
Manganese (Mn)	7439-96-5	70
Mercury (Hg)	7439-97-6	30
Molybdenum (Mo)	7439-93-7	10
Nickel (Ni)	7440-02-0	50
Potassium (K)	7440-09-7	200
Rubidium (Rb)	7440-17-7	10
Selenium (Se)	7782-49-2	40
Silver (Ag)	7440-22-4	70
Strontium (Sr)	7440-24-6	10
Thallium (Tl)	7440-28-0	20
Thorium (Th)	7440-29-1	10
Tin (Sn)	7440-31-5	60
Titanium (Ti)	7440-32-6	50
Vanadium (V)	7440-62-2	50
Zinc (Zn)	7440-66-6	50
Zirconium (Zr)	7440-67-7	10

Source: Refs. 1, 2, and 3

These data are provided for guidance purposes only .

TABLE 2
SUMMARY OF RADIOISOTOPE SOURCE CHARACTERISTICS

Source	Activity (mCi)	Half-Life (Years)	Excitation Energy (keV)	Elemental Analysis Range	
Fe-55	20-50	2.7	5.9	Sulfur to Chromium Molybdenum to Barium	K Lines L Lines
Cd-109	5-30	1.3	22.1 and 87.9	Calcium to Rhodium Tantalum to Lead Barium to Uranium	K Lines K Lines L Lines
Am-241	5-30	432	26.4 and 59.6	Copper to Thulium Tungsten to Uranium	K Lines L Lines
Cm-244	60-100	17.8	14.2	Titanium to Selenium Lanthanum to Lead	K Lines L Lines

Source: Refs. 1, 2, and 3

TABLE 3
SUMMARY OF X-RAY TUBE SOURCE CHARACTERISTICS

Anode Material	Recommended Voltage Range (kV)	K-alpha Emission (keV)	Elemental Analysis Range	
Cu	18-22	8.04	Potassium to Cobalt Silver to Gadolinium	K Lines L Lines
Mo	40-50	17.4	Cobalt to Yttrium Europium to Radon	K Lines L Lines
Ag	50-65	22.1	Zinc to Technetium Ytterbium to Neptunium	K Lines L Lines

Source: Ref. 4

Notes: The sample elements excited are chosen by taking as the lower limit the same ratio of excitation line energy to element absorption edge as in Table 2 (approximately 0.45) and the requirement that the excitation line energy be above the element absorption edge as the upper limit (L2 edges used for L lines). K-beta excitation lines were ignored.

TABLE 4
EXAMPLE PRECISION VALUES

Analyte	Average Relative Standard Deviation for Each Instrument at 5 to 10 Times the Lower Limit of Detection					
	TN 9000	TN Lead Analyzer	X-MET 920 (SiLi Detector)	X-MET 920 (Gas-Filled Detector)	XL Spectrum Analyzer	MAP Spectrum Analyzer
Antimony	6.54	NR	NR	NR	NR	NR
Arsenic	5.33	4.11	3.23	1.91	12.47	6.68
Barium	4.02	NR	3.31	5.91	NR	NR
Cadmium	29.84 ^a	NR	24.80 ^a	NR	NR	NR
Calcium	2.16	NR	NR	NR	NR	NR
Chromium	22.25	25.78	22.72	3.91	30.25	NR
Cobalt	33.90	NR	NR	NR	NR	NR
Copper	7.03	9.11	8.49	9.12	12.77	14.86
Iron	1.78	1.67	1.55	NR	2.30	NR
Lead	6.45	5.93	5.05	7.56	6.97	12.16
Manganese	27.04	24.75	NR	NR	NR	NR
Molybdenum	6.95	NR	NR	NR	12.60	NR
Nickel	30.85 ^a	NR	24.92 ^a	20.92 ^a	NA	NR
Potassium	3.90	NR	NR	NR	NR	NR
Rubidium	13.06	NR	NR	NR	32.69 ^a	NR
Strontium	4.28	NR	NR	NR	8.86	NR
Tin	24.32 ^a	NR	NR	NR	NR	NR
Titanium	4.87	NR	NR	NR	NR	NR
Zinc	7.27	7.48	4.26	2.28	10.95	0.83
Zirconium	3.58	NR	NR	NR	6.49	NR

These data are provided for guidance purposes only.

Source: Ref. 4

^a These values are biased high because the concentration of these analytes in the soil samples was near the lower limit of detection for that particular FPXRF instrument.

NR Not reported.

NA Not applicable; analyte was reported but was below the established lower limit detection.

TABLE 5
EXAMPLES OF PRECISION AS AFFECTED BY SAMPLE PREPARATION

Analyte	Average Relative Standard Deviation for Each Preparation Method		
	In Situ-Field	Intrusive-Undried and Unground	Intrusive-Dried and Ground
Antimony	30.1	15.0	14.4
Arsenic	22.5	5.36	3.76
Barium	17.3	3.38	2.90
Cadmium ^a	41.2	30.8	28.3
Calcium	17.5	1.68	1.24
Chromium	17.6	28.5	21.9
Cobalt	28.4	31.1	28.4
Copper	26.4	10.2	7.90
Iron	10.3	1.67	1.57
Lead	25.1	8.55	6.03
Manganese	40.5	12.3	13.0
Mercury	ND	ND	ND
Molybdenum	21.6	20.1	19.2
Nickel ^a	29.8	20.4	18.2
Potassium	18.6	3.04	2.57
Rubidium	29.8	16.2	18.9
Selenium	ND	20.2	19.5
Silver ^a	31.9	31.0	29.2
Strontium	15.2	3.38	3.98
Thallium	39.0	16.0	19.5
Thorium	NR	NR	NR
Tin	ND	14.1	15.3
Titanium	13.3	4.15	3.74
Vanadium	NR	NR	NR
Zinc	26.6	13.3	11.1
Zirconium	20.2	5.63	5.18

These data are provided for guidance purposes only.

Source: Ref. 4.

^a These values may be biased high because the concentration of these analytes in the soil samples was near the lower limit of detection.

ND Not detected.

NR Not reported.

TABLE 6
EXAMPLE ACCURACY VALUES

Analyte	Instrument															
	TN 9000				TN Lead Analyzer				X-MET 920 (SiLi Detector)				XL Spectrum Analyzer			
	n	Range of % Rec.	Mean % Rec.	SD	n	Range of % Rec.	Mean % Rec.	SD	n	Range of % Rec.	Mean % Rec.	SD	n	Range of % Rec.	Mean % Rec.	SD
Sb	2	100-149	124.3	NA	--	--	--	--	--	--	--	--	--	--	--	--
As	5	68-115	92.8	17.3	5	44-105	83.4	23.2	4	9.7-91	47.7	39.7	5	38-535	189.8	206
Ba	9	98-198	135.3	36.9	--	--	--	--	9	18-848	168.2	262	--	--	--	--
Cd	2	99-129	114.3	NA	--	--	--	--	6	81-202	110.5	45.7	--	--	--	--
Cr	2	99-178	138.4	NA	--	--	--	--	7	22-273	143.1	93.8	3	98-625	279.2	300
Cu	8	61-140	95.0	28.8	6	38-107	79.1	27.0	11	10-210	111.8	72.1	8	95-480	203.0	147
Fe	6	78-155	103.7	26.1	6	89-159	102.3	28.6	6	48-94	80.4	16.2	6	26-187	108.6	52.9
Pb	11	66-138	98.9	19.2	11	68-131	97.4	18.4	12	23-94	72.7	20.9	13	80-234	107.3	39.9
Mn	4	81-104	93.1	9.70	3	92-152	113.1	33.8	--	--	--	--	--	--	--	--
Ni	3	99-122	109.8	12.0	--	--	--	--	--	--	--	--	3	57-123	87.5	33.5
Sr	8	110-178	132.6	23.8	--	--	--	--	--	--	--	--	7	86-209	125.1	39.5
Zn	11	41-130	94.3	24.0	10	81-133	100.0	19.7	12	46-181	106.6	34.7	11	31-199	94.6	42.5

Source: Ref. 4. These data are provided for guidance purposes only.

n: Number of samples that contained a certified value for the analyte and produced a detectable concentration from the FPXRF instrument.

SD: Standard deviation; NA: Not applicable; only two data points, therefore, a SD was not calculated.

%Rec.: Percent recovery.

-- No data.

TABLE 7
EXAMPLE ACCURACY FOR TN 9000^a

Standard Reference Material	Arsenic			Barium			Copper			Lead			Zinc		
	Cert. Conc.	Meas. Conc.	%Rec.	Cert. Conc.	Meas. Conc.	%Rec.	Cert. Conc.	Meas. Conc.	%Rec.	Cert. Conc.	Meas. Conc.	%Rec.	Cert. Conc.	Meas. Conc.	%Rec.
RTC CRM-021	24.8	ND	NA	586	1135	193.5	4792	2908	60.7	144742	149947	103.6	546	224	40.9
RTC CRM-020	397	429	92.5	22.3	ND	NA	753	583	77.4	5195	3444	66.3	3022	3916	129.6
BCR CRM 143R	--	--	--	--	--	--	131	105	80.5	180	206	114.8	1055	1043	99.0
BCR CRM 141	--	--	--	--	--	--	32.6	ND	NA	29.4	ND	NA	81.3	ND	NA
USGS GXR-2	25.0	ND	NA	2240	2946	131.5	76.0	106	140.2	690	742	107.6	530	596	112.4
USGS GXR-6	330	294	88.9	1300	2581	198.5	66.0	ND	NA	101	80.9	80.1	118	ND	NA
NIST 2711	105	104	99.3	726	801	110.3	114	ND	NA	1162	1172	100.9	350	333	94.9
NIST 2710	626	722	115.4	707	782	110.6	2950	2834	96.1	5532	5420	98.0	6952	6476	93.2
NIST 2709	17.7	ND	NA	968	950	98.1	34.6	ND	NA	18.9	ND	NA	106	98.5	93.0
NIST 2704	23.4	ND	NA	414	443	107.0	98.6	105	106.2	161	167	103.5	438	427	97.4
CNRC PACS-1	211	143	67.7	--	772	NA	452	302	66.9	404	332	82.3	824	611	74.2
SARM-51	--	--	--	335	466	139.1	268	373	139.2	5200	7199	138.4	2200	2676	121.6
SARM-52	--	--	--	410	527	128.5	219	193	88.1	1200	1107	92.2	264	215	81.4

Source: Ref. 4. These data are provided for guidance purposes only.

^a All concentrations in milligrams per kilogram.

%Rec.: Percent recovery; ND: Not detected; NA: Not applicable.

-- No data.

TABLE 8

EXAMPLE REGRESSION PARAMETERS FOR COMPARABILITY¹

	Arsenic				Barium				Copper			
	n	r ²	Int.	Slope	n	r ²	Int.	Slope	n	r ²	Int.	Slope
All Data	824	0.94	1.62	0.94	1255	0.71	60.3	0.54	984	0.93	2.19	0.93
Soil 1	368	0.96	1.41	0.95	393	0.05	42.6	0.11	385	0.94	1.26	0.99
Soil 2	453	0.94	1.51	0.96	462	0.56	30.2	0.66	463	0.92	2.09	0.95
Soil 3	—	—	—	—	400	0.85	44.7	0.59	136	0.46	16.60	0.57
Prep 1	207	0.87	2.69	0.85	312	0.64	53.7	0.55	256	0.87	3.89	0.87
Prep 2	208	0.97	1.38	0.95	315	0.67	64.6	0.52	246	0.96	2.04	0.93
Prep 3	204	0.96	1.20	0.99	315	0.78	64.6	0.53	236	0.97	1.45	0.99
Prep 4	205	0.96	1.45	0.98	313	0.81	58.9	0.55	246	0.96	1.99	0.96

	Lead				Zinc				Chromium			
	n	r ²	Int.	Slope	n	r ²	Int.	Slope	n	r ²	Int.	Slope
All Data	1205	0.92	1.66	0.95	1103	0.89	1.86	0.95	280	0.70	64.6	0.42
Soil 1	357	0.94	1.41	0.96	329	0.93	1.78	0.93	—	—	—	—
Soil 2	451	0.93	1.62	0.97	423	0.85	2.57	0.90	—	—	—	—
Soil 3	397	0.90	2.40	0.90	351	0.90	1.70	0.98	186	0.66	38.9	0.50
Prep 1	305	0.80	2.88	0.86	286	0.79	3.16	0.87	105	0.80	66.1	0.43
Prep 2	298	0.97	1.41	0.96	272	0.95	1.86	0.93	77	0.51	81.3	0.36
Prep 3	302	0.98	1.26	0.99	274	0.93	1.32	1.00	49	0.73	53.7	0.45
Prep 4	300	0.96	1.38	1.00	271	0.94	1.41	1.01	49	0.75	31.6	0.56

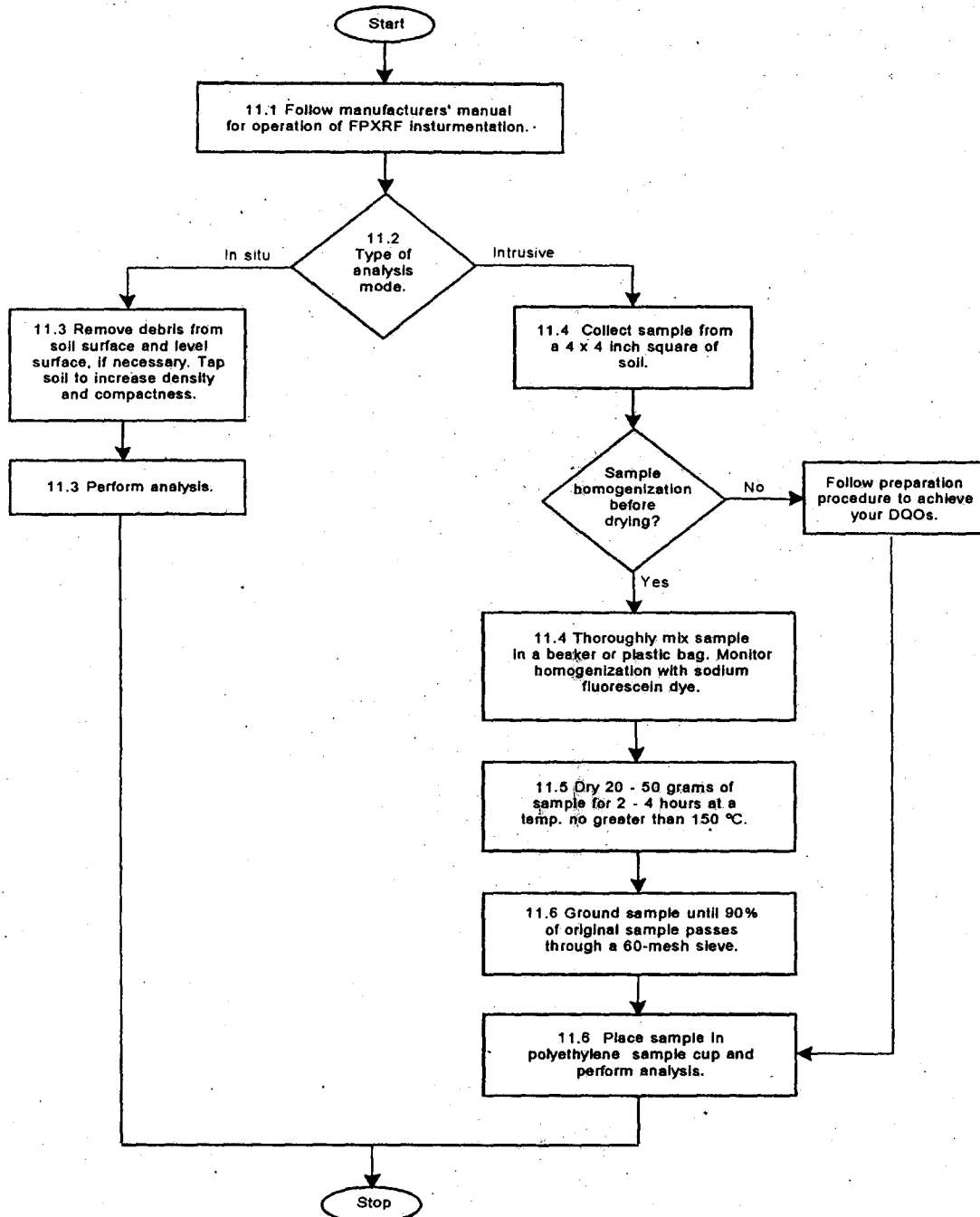
Source: Ref. 4. These data are provided for guidance purposes only.

¹ Log-transformed datan: Number of data points; r²: Coefficient of determination; Int.: Y-intercept

— No applicable data

METHOD 6200

FIELD PORTABLE X-RAY FLUORESCENCE SPECTROMETRY FOR THE DETERMINATION OF ELEMENTAL CONCENTRATIONS IN SOIL AND SEDIMENT



Site Designation	Sample Number	Analytical Table	Sample Date	Sample Time	EPA Split Sample #
PPC-8	AEH-0711-300	E	10/31/2007	11:00	
PPC-7	AEH-0711-301	E	10/31/2007	11:30	
PPC-5	AEH-0711-302	E	10/31/2007	12:20	
PPC-3A	AEH-0711-303	E	10/31/2007	13:00	
LOWER LAKE	AEH-0711-304	E	10/31/2007	13:35	
PPC-103	AEH-0711-305	E	10/31/2007	13:45	
PPC-103 DUP	AEH-0711-306	E	10/31/2007	14:20	
DI BLANK	AEH-0711-307	E	10/31/2007	14:45	
EH-57A	AEH-0711-100	F	11/12/2007	13:00	
EH-113	AEH-0711-101	F	11/12/2007	13:30	AEH-0711-101
EH-53	AEH-0711-102	F	11/12/2007	14:20	
EH-53 DUP	AEH-0711-103	F	11/12/2007	14:30	
EH-62	AEH-0711-107	F	11/13/2007	08:35	
EH-54	AEH-0711-108	F	11/13/2007	09:25	AEH-0711-108
EH-63	AEH-0711-109	F	11/13/2007	10:00	
EH-63 DUP	AEH-0711-110	F	11/13/2007	10:10	
EH-64	AEH-0711-111	F	11/13/2007	11:45	
EH-65	AEH-0711-112	F	11/13/2007	12:20	
EH-107	AEH-0711-113	F	11/13/2007	12:55	
EH-115	AEH-0711-114	F	11/13/2007	13:35	AEH-0711-114
EH-110	AEH-0711-115	F	11/13/2007	14:10	
RINSATE BLANK	AEH-0711-116	F	11/13/2007	15:00	
DI BLANK	AEH-0711-117	F	11/13/2007	15:20	
EH-101	AEH-0711-118	F	11/14/2007	10:12	AEH-0711-118
EH-51	AEH-0711-119	F	11/14/2007	10:42	
EH-51 DUP	AEH-0711-120	F	11/14/2007	10:47	
EH-102	AEH-0711-121	F	11/14/2007	11:39	AEH-0711-121
EH-52	AEH-0711-122	F	11/14/2007	12:02	AEH-0711-122
EH-58	AEH-0711-123	F	11/14/2007	12:37	AEH-0711-123
DH-7	AEH-0711-124	F	11/14/2007	13:52	AEH-0711-124
RINSATE BLANK	AEH-0711-125	F	11/14/2007	14:30	
DI BLANK	AEH-0711-126	F	11/14/2007	14:50	
DH-11	AEH-0711-127	F	11/15/2007	09:49	AEH-0711-127
EH-114	AEH-0711-128	F	11/15/2007	11:19	AEH-0711-128
EH-116	AEH-0711-129	F	11/15/2007	11:49	AEH-0711-129
EH-117	AEH-0711-130	F	11/15/2007	12:17	AEH-0711-130
EH-112	AEH-0711-131	F	11/15/2007	13:39	AEH-0711-131
EH-104	AEH-0711-132	F	11/15/2007	14:16	
EH-104 DUP	AEH-0711-133	F	11/15/2007	14:21	
DI BLANK	AEH-0711-134	F	11/15/2007	15:20	
RINSATE BLANK	AEH-0711-135	F	11/15/2007	15:30	
EH-103	AEH-0711-136	F	11/16/2007	09:23	
EH-61	AEH-0711-137	F	11/16/2007	10:28	
DH-54	AEH-0711-138	F	11/16/2007	10:50	
EH-59	AEH-0711-139	F	11/16/2007	11:33	AEH-0711-139
MW-3	AEH-0711-140	CAMU + TSS	11/16/2007	13:08	
DI BLANK	AEH-0711-141	CAMU	11/16/2007	13:45	
MW-4	AEH-0711-142	CAMU	11/16/2007	14:15	
RINSATE BLANK	AEH-0711-143	CAMU	11/16/2007	15:00	

MW-1	AEH-0711-144	CAMU	11/26/2007	12:40	
MW-2	AEH-0711-145	CAMU	11/26/2007	13:20	
MW-5	AEH-0711-146	CAMU	11/26/2007	14:00	
MW-5 DUP	AEH-0711-147	CAMU	11/26/2007	14:10	
MW-7	AEH-0711-148	--	11/26/2007		No Sample - Low W
MW-11	AEH-0711-149	CAMU	11/26/2007	14:30	
MW-9	AEH-0711-150	CAMU	11/26/2007	15:00	
RINSATE BLANK	AEH-0711-151	CAMU	11/26/2007	15:10	
DI BLANK	AEH-0711-152	CAMU	11/26/2007	15:20	
MW-8	AEH-0711-153	CAMU	11/26/2007	15:40	
MW-10	AEH-0711-154	CAMU	11/27/2007	09:00	
MW-6	AEH-0711-155	CAMU	11/27/2007	09:40	
DH-3	AEH-0711-156	F	11/27/2007	10:40	
DH-3 DUP	AEH-0711-157	F	11/27/2007	10:50	
RINSATE BLANK	AEH-0711-158	F	11/27/2007	11:00	
DI BLANK	AEH-0711-159	F	11/27/2007	11:10	
DH-2	AEH-0711-160	F	11/27/2007	11:25	
DH-1	AEH-0711-161	F	11/27/2007	11:55	
DH-63	AEH-0711-162	F	11/27/2007	13:10	
DH-48	AEH-0711-163	--	11/27/2007	13:30	Dry - No
DH-49	AEH-0711-164	--	11/27/2007	13:40	Dry - No
DH-6	AEH-0711-165	F	11/27/2007	13:45	AEH-0711-165
DH-15	AEH-0711-166	F	11/27/2007	14:45	AEH-0711-166
DH-10A	AEH-0711-167	F	11/27/2007	15:10	AEH-0711-167
DH-52	AEH-0711-168	F	11/28/2007	09:15	AEH-0711-168
DH-53	AEH-0711-169	F	11/28/2007	09:40	AEH-0711-169
DH-51	AEH-0711-170	F	11/28/2007	10:30	
DH-51 DUP	AEH-0711-171	F	11/28/2007	10:45	
STW-7	AEH-0711-172	F	11/28/2007	11:05	
STW-9	AEH-0711-173	F	11/28/2007	11:25	
DH-50	AEH-0711-174	F	11/28/2007	11:50	
DI BLANK	AEH-0711-175	F	11/28/2007	12:30	
RINSATE BLANK	AEH-0711-176	F	11/28/2007	12:40	
STW-8	AEH-0711-177	F	11/28/2007	13:20	
STW-4	AEH-0711-178	F	11/28/2007	13:40	
STW-1	AEH-0711-179	F	11/28/2007	14:00	
DH-24	AEH-0711-180	F	11/28/2007	14:35	
SPARGE 3	AEH-0711-181	F	11/28/2007	15:00	
DH-67	AEH-0711-182	F	11/29/2007	09:40	
DH-62	AEH-0711-183	F*	11/29/2007	10:35	
DH-62 DUP	AEH-0711-184	F*	11/29/2007	10:33	
DI BLANK	AEH-0711-185	F	11/29/2007	14:30	
RINSATE BLANK	AEH-0711-186	F	11/29/2007	14:40	
DH-66	AEH-0711-187	F	12/4/2007	10:05	
DH-8	AEH-0711-188	F	12/4/2007	11:10	
DH-20	AEH-0711-189	F	12/4/2007	11:55	
DH-20 DUP	AEH-0711-190	F	12/4/2007	12:00	
DH-5	AEH-0711-191	F	12/4/2007	13:40	AEH-0711-191
RINSATE BLANK	AEH-0711-192	F	12/4/2007	14:15	AEH-0711-192
APSD-15	AEH-0711-193	F*	12/4/2007	14:43	
DI BLANK	AEH-0711-194	F	12/4/2007	13:00	AEH-0711-194
APSD-16	AEH-0711-195	F*	12/4/2007	09:30	AEH-0711-195

APSD-1	AEH-0711-196	F*	12/5/2007	10:10	
APSD-7	AEH-0711-197	F	12/5/2007	10:42	
APSD-4	AEH-0711-198	F*	12/5/2007	11:35	
APSD-3	AEH-0711-199	F*	12/5/2007	12:01	
DH-14	AEH-0711-200	F	12/5/2007	13:15	AEH-0711-200
DH-14 DUP	AEH-0711-201	F	12/5/2007	13:20	AEH-0711-201
DI BLANK	AEH-0711-202	F	12/5/2007	13:30	
SDMW-4	AEH-0711-203	F*	12/5/2007	14:12	
SDMW-1	AEH-0711-204	F*	12/5/2007	14:50	
RINSATE BLANK	AEH-0711-205	F	12/5/2007	15:20	
DH-23	AEH-0711-206	F	12/7/2007	09:45	
DH-23 DUP	AEH-0711-207	F	12/7/2007	10:10	
DH-4	AEH-0711-208	F	12/7/2007	10:50	AEH-0711-208
DH-47	AEH-0711-209	F	12/7/2007	11:35	
DH-58	AEH-0711-210	F	12/7/2007	12:05	
DH-55	AEH-0711-211	F	12/7/2007	13:45	AEH-0711-211
DH-42	AEH-0711-212	F	12/7/2007	14:55	
RINSATE BLANK	AEH-0711-213	F	12/7/2007	14:35	
DI BLANK	AEH-0711-214	F	12/7/2007	15:15	
DH-36	AEH-0711-215	F	12/10/2007	0945	
EH-50	AEH-0711-216	F	12/10/2007	11:00	
EH-50 DUP	AEH-0711-217	F	12/10/2007	11:15	
DI BLANK	AEH-0711-218	F	12/10/2007	11:30	
EH-111	AEH-0711-219	F	12/10/2007	11:45	AEH-0711-219
EH-106	AEH-0711-220	F	12/10/2007	13:05	AEH-0711-220
EH-100	AEH-0711-221	F	12/10/2007	14:35	
RINSATE BLANK	AEH-0711-222	F	12/10/2007	14:50	
EH-60	AEH-0711-223	F	12/10/2007	14:55	
EH-109	AEH-0711-224	F	12/10/2007	15:30	
DH-59	AEH-0711-225	F	12/11/2007	09:45	
DH-19R	AEH-0711-226	F	12/11/2007	10:40	
DH-19R DUP	AEH-0711-227	F	12/11/2007	11:05	
DH-29	AEH-0711-228	F*	12/11/2007	11:45	
DI BLANK	AEH-0711-229	F	12/11/2007	12:30	
APSD-10	AEH-0711-230	F	12/11/2007	13:30	
DH-12	AEH-0711-231	--	12/11/2007	14:00	Dry - No
DH-13	AEH-0711-232	F*	12/11/2007	14:40	
RINSATE BLANK	AEH-0711-233	F	12/11/2007	15:15	
DH-64	AEH-0711-234	F	12/11/2007	15:45	AEH-0711-234
DH-17	AEH-0711-235	F	12/12/2007	09:20	
DH-17 DUP	AEH-0711-236	F	12/12/2007	09:30	
DH-57	AEH-0711-237	F	12/12/2007	09:50	
DI BLANK	AEH-0711-238	F	12/12/2007	10:10	
SDMW-2	AEH-0711-239	F*	12/12/2007	10:45	
DH-65	AEH-0711-240	F	12/12/2007	11:15	AEH-0711-240
DH-56	AEH-0711-241	F	12/12/2007	11:45	AEH-0711-241
DH-18	AEH-0711-242	F	12/12/2007	12:35	
APSD-2	AEH-0711-243	F*	12/12/2007	13:05	
TW-1	AEH-0711-244	F*	12/12/2007	14:30	
RINSATE BLANK	AEH-0711-245	F	12/12/2007	14:20	
DH-33	AEH-0711-246	F*	12/12/2007	15:00	
DH-34	AEH-0711-247	F*	12/12/2007	15:35	AEH-0711-247

SDMW-5	AEH-0711-248	F*	12/13/2007	09:00	
SDMW-5 DUP	AEH-0711-249	F*	12/13/2007	09:10	
SDMW-3	AEH-0711-250	F*	12/13/2007	09:50	
DH-32	AEH-0711-251	--	12/13/2007	00:00	Dry - No
DH-37	AEH-0711-252	F	12/13/2007	10:30	
DH-35	AEH-0711-253	F*	12/13/2007	11:10	
DH-21	AEH-0711-254	F*	12/13/2007	12:00	
RINSATE BLANK	AEH-0711-255	F	12/13/2007	11:50	
DI BLANK	AEH-0711-256	F	12/13/2007	12:15	
DH-30	AEH-0711-257	F*	12/13/2007	13:00	
DH-27	AEH-0711-258	F*	12/13/2007	13:40	
DH-31	AEH-0711-259	--	12/13/2007	00:00	Well Casing Brok
DH-38	AEH-0711-260	--	12/13/2007	00:00	Dry - No
DH-16	AEH-0711-261	--	12/13/2007	00:00	Dry - No
DH-22	AEH-0711-262	--	12/13/2007	00:00	Dry - No
DH-9	AEH-0711-263	--	12/13/2007	00:00	Dry - No

* INDICATES SAMPLE WAS TO BE ANALYZED FOR TOTAL METALS

APPENDIX C

2007 CLEANING AND DEMOLITION WORK PLAN (URS, 2007)

HAZARDOUS MATERIALS ABATEMENT PLAN

**ASBESTOS CONTAINING MATERIALS AND LEAD DUST CLEANING
ASSOCIATED WITH THE
ASARCO PHASE 4 BUILDING CLEANING AND DEMOLITION**

Submitted to:

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April 16, 2007

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1.0 Introduction

- 1) IRS Environmental of WA (IRSE) has been contracted by Cleveland Wrecking Company, to abate hazards associated with the asbestos-containing materials (ACMs) that were identified in the structures and lead dust cleaning before selective demolition of the Asarco Lead Smelter Plant, located in East Helena, Montana.
- 2) This work plan describes the methods and procedures IRSE shall utilize to remove the subject ACM and lead dust. Sections 2.0 through 7.0 describe the applicable standards and regulations, site supervision, removal procedures and waste handling, WISHA air monitoring and the laboratory analytical procedures for each building scheduled for ACM abatement and/or lead dust cleaning. Appendix A of this work plan identifies the specific scope of work for each building scheduled for asbestos abatement and/or lead dust cleaning.
- 3) This plan is intended to address removal of ACM and lead dust cleaning from the subject structures.

2.0 Asbestos Abatement and Lead Dust Cleaning- Applicable Standards and Guidelines

- 1) Asbestos abatement work under this contract will be performed in accordance with all federal, state, and local laws, regulations, standards, and codes governing asbestos abatement. Before starting work, IRSE will provide proper notification Montana Department of Environmental Quality (DEQ).
- 3) IRSE will comply with all provisions of the Montana Asbestos Work Practices and Procedures Manual adopted and incorporated by the reference in the administrative Rules of Montana, Title 17, Chapter 74 Subchapter 3 as it pertains to safety in employment and the applicable provisions of DEQ General Safety and Health Standards as it pertains to occupational safety and health in the workplace. In addition, IRSE will comply with Title 29 CFR 1910 and 1926. The most recent edition of any regulation, standards, document, or code will be in effect. When conflict among the requirements or with this work plan exists, the more stringent requirement(s) will be applied.

In addition, IRSE will comply with all provisions of the Federal OSHA standards applicable to construction work where employees may be exposed to lead (Title 29 CFR 1910 and 1926.62). The most recent edition of any regulation, standards, document, or code will be in effect. When conflict among these requirements or with this work plan exists, the more stringent requirement(s) will be applied.

- 4) Initial exposure assessments will also be conducted at the beginning of all abatement activities in accordance with Title 29 CFR 1926.1101.

3.0 Site Supervision and Certification

- 1) IRSE is a licensed asbestos abatement contractor in the State of Montana. All work will be supervised by Mark Kazemba, a state-certified Asbestos Supervisor and has completed the 40 hour hazwoper training. All supervisors are AHERA trained competent persons.
- 2) Supervisory duties will include, but will not be limited to, controlling site access and implementing proper air sampling protocols, as well as appropriate controls to prevent exposure to ACMs and lead. It is also the competent person's responsibility to ensure adequacy of engineering controls and to exercise the authority to select appropriate control strategies up to and including shutdown of the work if conditions are warranted.
- 3) All workers conducting ACM removal activities will be medically qualified and trained for asbestos work involving respirator usage.
- 4) All workers conducting lead dust cleaning will be medically qualified and trained for lead removal work involving respirator usage.

4.0 Site Safety and Health Plan

4.1 General

- 1) IRSE will be responsible for safety and health at the Asarco Phase 4 Building Cleaning and Demolition Project during anticipated asbestos abatement and lead cleaning activities. This includes, but is not limited to, electrical safety, equipment operation safety, mechanical (tool) safety, fire safety, and personnel protective equipment safety.
- 2) The *IRSE Site Specific Hazard Analysis* plan for the Asarco Phase 4 Building Cleaning and Demolition Project (see Appendix D) was developed to be used in conjunction with this Asbestos and Lead Dust Abatement Work Plan. Information found in this Work Plan, including air sampling, decontamination procedures, and work activities should be used to supplement the information contained in the *IRSE Site Specific Hazard Analysis Plan for the Asarco Phase 4 Building Cleaning and Demolition Project*. (see Appendix D).

4.2 Work Site Safety

- 1) Before initiating asbestos or lead cleaning abatement work, IRSE will set and post emergency procedures in a conspicuous place at each active abatement site. The emergency procedures will include provisions for the following:
 - Evacuation of injured workers
 - Emergency and fire egress routes from all work areas, including local telephone numbers for fire and medical emergency personnel, site of hospital routing maps
 - Copies of applicable insurance certificates
 - Entry logs.
- 2) At a minimum, two IRSE personnel with the proper training and certified in basic first aid and cardiopulmonary resuscitation (FA/CPR) will be at each active work site. A general first aid kit will be maintained in the support area for treating minor medical problems.

4.2.1 Work Area Access

Removal work areas will be clearly marked with barrier tape or other means to warn personnel of the hazards. Immediately adjacent to the removal work area (regulated work areas) a decontamination area for equipment and personnel will be established. The remainder of the IRSE project area will be designated as the support zone. No special markings or warning labels are required for this area.

4.2.2 Hazard Briefing/Site Safety Operation

- 1) No person will be allowed on the site during active abatement activities without first being given a site hazard briefing. In general, the briefing will consist of a review of the Work Plan and the tailgate safety meeting. All persons on the site, including visitors, must sign the site-specific tailgate safety meeting form. Tailgate safety meetings shall be held prior to the start of any work activities involving all personnel on site.

4.2.3 Entry Log

- 1) The IRSE Competent Person shall record the names and times of entry and exit of all personnel who enter the asbestos removal and lead dust cleaning work areas (regulated work area).

4.2.4 Entry Requirements

- 1) Entry into regulated work areas shall be only by personnel authorized by the State Certified Supervisor, Competent Persons, and Personnel authorized to enter regulated work areas shall be trained and medically evaluated and shall wear the PPE required.
- 2) IRSE will be responsible for the security of the work areas of the building(s) involved in the abatement project and secure all assigned entrances and exits at the end of the work day so as to prevent unauthorized entry.
- 3) The tailgate safety meeting log will be maintained and reflect the name of any and personnel attending.

4.3 Worker Protection Requirements

4.3.1 General

- 1) Danger signs and tape will be posted and meet the specifications of DEQ and OSHA Construction Standards wherever regulated work areas are created. Signs will be posted at a distance sufficiently far enough away from the work area to permit an employee to read the sign and take the necessary protective measures to avoid exposure.
- 2) Electrical power systems located in active abatement areas are de-energized, shut down and locked out and temporary power and lighting sources (if applies) will be provided to the area. The temporary power will be installed in a manner that is consistent with all applicable electrical code, WISHA, OSHA, and IT requirements for temporary electrical systems (if applies).
- 3) A sufficient quantity of negative pressure ventilation units equipped with HEPA filtration and operated in accordance with ANSI 29.2 through 79 (local exhaust ventilation requirements) shall be utilized when needed to provide adequate ventilation, or to provide four air changes per hour inside negative pressure enclosures.

4.3.2 Asbestos Abatement Training

- 1) Training shall be provided to all employees or agents who may be required to disturb asbestos for abatement and auxiliary purposes and to supervisory personnel who may be involved in planning, execution, design, or inspection of abatement projects. Asbestos abatement workers and supervisors must have successfully completed Montana State approved training courses and have state certification cards on site at all times when working. Inspection undertaken to determine the presence of additional asbestos will be conducted by personnel who are currently EPA Certified Building Inspectors. Project design personnel will also be EPA certified. Worker and supervisory certificates and training documentation.

2) Worker training shall provide, at a minimum, information on the following topics:

- The health hazards of asbestos, including the nature of various asbestos-related diseases, routes of exposure, known dose-response relationships, the synergistic relationship between asbestos exposure and cigarette smoking, latency periods for disease and health basis for standards.
- The physical characteristics of asbestos, including fiber size, aerodynamic properties, physical appearance, and uses.
- Employee PPE, including the types and characteristics of respirator classes, limitations of respirators, proper selection, inspection, donning, use, maintenance and storage of respirators, field testing the face-piece-to-face seal (positive and negative pressure fitting tests), qualitative and quantitative fit testing procedures, variations between laboratory and field fit factors, factors that affect respirator fit (e.g., facial hair), selection and use of disposable clothing, use and handling of launderable clothing, nonskid shoes, gloves, eye protection, and hard hats.
- Medical monitoring requirements for workers include required and recommended tests, reasons for medical monitoring, and employee access to records.
- Air monitoring procedures and requirements for workers, including description of equipment and procedures, reasons for monitoring, types of samples, and current standards with recommended changes.
- Work practices for asbestos abatement include proper construction and maintenance of air-tight plastic barriers, job set-up of airlocks, worker decontamination systems and waste transfer airlocks, posting of warning signs, engineering controls, electrical and ventilation system lockout, proper working techniques, waste cleanup and disposal procedures.
- Personal hygiene, including entry and exit procedures for the work area, use of showers and prohibition of eating, drinking, smoking, and chewing in the work area.
- Special safety hazards that may be encountered, including electrical hazards, air contaminants (CO₂ wetting agents, encapsulant, and materials from Owner's operation), fire and explosion hazards, scaffold and ladder hazards, slippery surfaces, confined spaces, heat stress, and noise.
- Workshops affording both supervisory personnel and abatement workers the opportunity to see (and experience) the construction of containment barriers and decontamination facilities.

- Supervisory personnel shall, in addition, receive training on contract specifications, liability insurance and bonding, legal considerations related to abatement establishing respiratory protection medical surveillance programs, EPA, OSHA, and State record-keeping requirements.

- 3) Training must be provided by Montana State approved training providers and must be current, each employee having training certification renewed every 12 months as required by regulation.

4.3.3 Lead Dust Removal Training

- 1) Training shall be provided to all employees or agents who may be required to disturb Lead Dust, and to supervisory personnel who may be involved in planning, execution, design, or inspection of Lead Dust removal projects.

Lead Dust removal supervisors will have successfully completed the Lead in Construction Training Course and will hold current certification. Lead removal workers will have completed Four Hour Lead Awareness Training for Lead in Construction as required by WISHA and OSHA.

- 2) Worker training shall provide, at a minimum, information on the following topics:

- The Content Lead and Title 29 CFR 1910 and 1926.62
- The specific nature of operations which could result in exposures to lead above the action level
- Training requirements for respirators as required by 296-62 WAC, Part E and 29 CFR 1926.103
- The purpose and a description of the medical surveillance program, and the medical removal protection program including information concerning the adverse health effects associated with excessive exposure to lead (with particular attention to the adverse reproductive effects on both males and females and hazards to the fetus and additional precautions for employees who are pregnant)
- The engineering controls and work practices associated with the employees job assignment including training of employees to follow relevant good work practices described in Appendix B, 29 CFR 1926
- Instructions that chelating agents should not routinely be used to remove lead from the body and should not be used at all except under the direction of a licensed physician

4.3.4 Respiratory Protection

- 1) Each worker involved in abatement shall be instructed in the proper use of respirators.
- 2) A sufficient quantity of respirator filters approved for asbestos and lead work will be available. Respirators and unused filters, if applicable, will be stored at the job site in the changing room to protect them completely. The filters used will be high efficiency particulate air (HEPA).
- 3) Workers must perform a field fit test/inspection of their respirator as specified by the manufacturer.
- 4) No one wearing a beard shall be permitted to don a respirator and enter the work area.
- 5) Additional respirators and training on their donning and use must be available at the work site for authorized visitors who may request to enter the work area.

4.3.4 Other Personal Protective Equipment

- 1) Personal protective equipment that includes Tyvek or polypropylene coveralls with hoods, hard hats, respirators, and nitrile gloves will be provided in sufficient quantities and adequate sizes for all workers and authorized visitors.
- 2) Protective eyewear and hard hats shall be provided as required for workers and authorized visitors for use outside of the containment area.

4.3.5 Medical Monitoring –Asbestos Abatement

- 1) Medical monitoring must be provided to any employee that may be exposed to asbestos in excess of background levels during any phase of these abatement projects. The purposes of a medical monitoring program are to determine work relatedness of disease, as well as to ensure fitness for duty, particularly the ability to wear a respirator. The medical monitoring program provides the appropriate setting to share this information. Medical monitoring shall include, at a minimum, the requirements of 29 CFR 1926 and IRSE Medical Compliance Plan.
 - A work/medical history to elicit symptomatology of respiratory disease.
 - A chest x-ray (posterior-anterior, 14 x 13 in.) taken by a certified radiologist technician and evaluated by a certified B-reader.
 - A pulmonary function test, including forced vital capacity (FVC) and forced expiratory volume at one second (FEV1), and FEV1/FVC ratio (administered by a NIOSH or American Thoracic Society (ATS) Certified Pulmonary Technician) and interpreted and compared to standardized normalcy by a Board Certified Pulmonary Specialist.

- Employees shall be given the opportunity to be evaluated by a physician to determine their capability to work safely while breathing through the added resistance of a respirator. Examining physicians shall be aware of the nature of respiratory protective devices and their contributions to breathing resistance. They shall also be informed of the specific types of respirators the employees shall be required to wear and the work they will be required to perform, as well as special workplace conditions, such as high temperatures, high humidity, and chemical contaminants to which employees may be exposed.
- Evaluation of groups of workers should take into consideration epidemiologic principles as suggested by the ATS in its statement on the work relatedness of disease adopted in 1982.

4.3.6 Medical Monitoring – Lead Abatement

- 1) Medical monitoring will be provided to any employee that may be exposed to airborne lead in excess of the action level of 30 μg^3 during any phase of the Lead dust cleaning process. The purposes of a medical monitoring program is to provide baseline blood lead levels and to provide ongoing biological monitoring to insure engineering controls are effective, as well as to ensure fitness for duty, particularly the ability to wear a respirator. The medical monitoring program provides the appropriate setting to share this information.

Medical monitoring shall include, at a minimum, the requirements of 29 CFR 1926.62

- An accurate record for each employee including Name, Social Security Number, and a description of the duties of each employee.
- A copy of the physician's written opinions, including those related to fitness for respirator use
- Results of any airborne exposure monitoring done on or for that employee and provided to the Physician
- Each employee shall be given the opportunity to be evaluated by a physician to determine their capability to work safely while breathing through the added resistance of a respirator. Examining physicians shall be aware of the nature of respiratory protective devices and their contributions to breathing resistance. They shall also be informed of the specific types of respirators the employees shall be required to wear and the work they will be required to perform
- Any employee medical complaints related to exposure to lead
- A copy medical examination results and description of the laboratory procedures and a copy of any standards or guidelines used to interpret the test results or references to that information (to be retained by doctor).
- A copy of the results of biological monitoring.

4.4 Emergency Contingency Plan

- 1) Site personnel must be prepared to respond and act quickly in the event of an emergency. The following emergency preparedness and response procedures will aid in protecting site workers and the surrounding environment.

4.4.1 General

- 1) The Site Safety Officer will establish evacuation routes and assembly areas for the abatement site. All personnel entering the work area will be informed of these routes and assembly areas. Evacuation routes, rally points, and the locations of emergency equipment will be included on the site map contained within the work plan prior to the initiation of on-site activities.
- 2) In the case of site evacuation, the following procedures shall be observed:
 - Stop working, secure equipment, and return to the decontamination area for decontamination
 - Exit building
 - Walk to the designated rally point using the evacuation route
 - Notify the on-site IRSE Competent Person, Project Manager and the Environmental Health and Safety representative
 - Remain at the rally point until further information is received
- 3) Personnel should not stand in roads, driveways, or in front of gates, as these locations may be used by emergency and support vehicles entering the site.
- 4) Each site activity will be evaluated for the potential for fire, explosion, chemical release, or other catastrophic events. Unusual events, activities, chemicals, and conditions will be immediately reported to the Competent Person.

4.4.2 Emergency Procedures

- 1) If an incident (personal or vehicle accident, property damage, or near miss) occurs, the following procedures will be used:
 - The Competent Person will evaluate the incident, assess the need for assistance, and notify the Project Manager.
 - The Competent Person will call for outside assistance as needed.
 - The Competent Person will act as liaison between outside agencies and on-site personnel.

- The Competent Person will take appropriate measures to stabilize the incident scene.
- The IRSE Project Manager will provide technical guidance to the Competent Person as needed and notify the CWC's representative.
- The Competent Person will ensure that any injured employee's supervisor completes an injury report form and forwards the form to the Project Manager or Site Safety Officer.

4.4.3 Safety Signals

- 1) While working on site, the following hand signals will be used for communication when necessary.

<u>Hand Signal</u>	<u>Meaning</u>
Arms crossed over head	Shut off equipment
Hand gripping throat	Out of air, can't breathe
Both hands around waist	Leave area immediately
Wave hands over head	Need assistance
Thumbs up	Okay, I am all right, I understand
Thumbs down	No, negative

- 2) Vehicle or portable air horns will be used for alarm signals as follows:

- One long blast: Emergency evacuation of the site
- Two short blasts: Clear working area around powered or moving equipment

4.4.4 Medical Emergency

4.4.4.1 General

- 1) Prior to field work, Site Health and Safety Officer will contact and coordinate with all potential emergency response organizations so that they will be aware of any potential site hazards and can meet training and medical requirements. All employee injuries must be promptly reported to the Competent Person. The Competent Person will:
 - Ensure that the injured employee receives prompt first aid and medical attention.
 - Contact Emergency Services at 911 and state clearly "This is a emergency at the East Helena Asarco Plant" ever medical attention is required to ensure that appropriate services are provided.
 - Complete the appropriate form or forms and submit them to the Project Manager or Site Safety Officer within one business day of an incident. Forms include:
 - Supervisor's Employee Injury Report (to be completed by the employee's supervisor)

- Vehicle Accident Report
- General Liability, Property Damage and Loss Report
- Ensure that the Project Manager and Site Safety Officer are immediately notified of the incident.
- Initiate an investigation of the incident, with the assistance of a representative prior to restarting work activities.

4.4.4.2 Chemical Inhalation

- 1) Any employee complaining of symptoms of chemical overexposure will be removed from the work area and transported to the designated medical facility for examination. The Competent Person must contact the Project Manager and Site Safety and Health Officer immediately.

4.4.4.3 Eye Contact

- 1) Project personnel who have had contaminants splashed in their eyes or who have experienced eye irritation while on the site shall immediately proceed to the eyewash station. Do not decontaminate before using the eyewash. Remove whatever protective clothing is necessary to use the eyewash. Thoroughly flush the eye with clean water. Arrange prompt transport to the designated medical facility.

4.4.4.4 Skin Contact

- 1) Project personnel who have had skin contact with contaminants will, unless the contact is severe, precede through the decontamination facilities to the wash-up area. Personnel will remove any contaminated clothing, and then wash the affected area with water. The worker should be transported to the medical facility listed below if they show any sign of skin reddening or irritation or if they request a medical examination, MSDS should be made available to medical staff for evaluation, if available.

4.4.4.5 Personal Injury Accident

- 1) In the event of a personal injury accident, the Competent Person will assess the nature and seriousness of the injury. In the case of serious or life-threatening injuries, normal decontamination procedures may be abbreviated or bypassed. Less serious injuries, such as strains, sprains, minor cuts, and contusions, may only be treated after the employee has been decontaminated.

Following decontamination, an IRSE project team member qualified in FA/CPR will administer suitable first aid. The Competent Person will then, if necessary, arrange transport to the appropriate medical facility. The Project Manager must be notified of all recordable injuries, illnesses, and vehicle accidents. Washington State Department of Labor and Industries must be verbally notified within eight hours of any accident resulting in a fatality, within 24 hours of in-patient hospitalization.

- 2) Because the bites of snakes, spiders, scorpions are rare, the recommended treatment is outlined here as a reminder in case of a bite. DO NOT cut the site of the bite and suck out the venom, but rather lie the victim down and keep the person calm. Try to keep the affected area lower than the heart. Ice may be applied to the area of the bite but make sure that there is no direct skin contact with the ice. Use a towel for insulation to prevent freezing the skin. DO NOT use a tourniquet or constricting band on the affected limb. Get the victim to medical attention.

4.4.4.6 Fire

- 1) In the case of a fire on the site, the Competent Person will assess the situation and determine the proper response. All personnel NOT trained in the use of fire extinguishers shall evacuate the area involved. Only IRSE personnel trained in the use of extinguishers may attempt to extinguish the fire with available extinguishers if it is safe to do so. If these trained employees do not wish to make the attempt, they are to evacuate also. In the event of ANY fire, IRSE will call the East Helena Fire Department at the number listed in the Site Specific Safety Plan and notify the Site Safety and Health Officer immediately. Fire fighting is a job for the fire department. No property or equipment is so important as to risk an employee's life.

4.5 Failure of Work Area Containment System (where applicable)

- 1) The work enclosure and negative air system will be closely monitored for failure or a breach. If such an event occurs, the work inside would immediately stop and the problem resolved. A breach in containment could be quickly repaired with duct tape; if the negative air system is the source of problems, the cause of the malfunction will be determined, and the necessary repairs or replacements made so that work can resume.
- 2) Asbestos waste that can be vacuumed will be contained in a HEPA vacuum. The bagged waste from the operation would not create a spill hazard. The asbestos waste inside the HEPA vacuum will be removed inside a containment area built specifically for this purpose.

4.6 Emergency Information

- 1) Before the start of the project, contact will be made with local authorities and emergency services to establish a communication channel during an event of emergency and to familiarize the project personnel with the communication procedures and services. Pertinent emergency information will be included on the daily tailgate safety meeting forms.
- 2) The Site Specific Safety Plan at Appendix E contains directions to St Peter's Hospital (see also Emergency Phone List attached).

4.6.1 Key Project Personnel

IRSE Project Manager	Carl Burnham	509-927-7867	office
		509-998-8257	mobile
IRSE Competent Person	Mark Kazemba	509-884-4267	mobile
IRSE Health and Safety Officer	Robert Reed	509-927-7867	
CWC Project Manager	_____	_____	office
		_____	mobile
CWC Safety and Health Officer	_____	_____	office
		_____	mobile
Asarco Acting Plant Manager	Blaine Cox	406-227-7100	office
Asarco Environmental Manager	Jon Nickel	406-227-7100	office
Department of Environmental Quality		406-444-5300	office
OSHA Regional Office		406-247-7494	office (Billings)
Montana DEQ (NEHEPS)	John Podolinski	406-444-2690	office
		406-444-1499	fax
Occupational Medicine Associates	Dr. Royce Van Gerpin	509-455-5555	office

4.6.2 Medical Care Facilities

Saint Peter's Hospital
 2475 Broadway
 Helena, MT 59601
 (253) 512-2708

4.6.3 Emergency Telephone Numbers

Emergency	911 Notify Emergency Crews: Say <i>"This is an emergency at the E Helena Asarco lead smelter"</i>
National Response Center (spills)	800 - 424-8802
Regional Poison Control Center	800 - 525-5042
Fire Department	406-447-5477 or 911
Police Department	406-442-3233 or 911

5.0 Asbestos and Lead Removal Techniques and Procedures

- 1) Asbestos-containing materials that will be removed from the site buildings and are judged by a competent person to be friable (i.e., those ACMs that, when dry, can be crushed, crumbled, pulverized, or otherwise rendered to a dust by hand pressure) will be packaged and stored in a manner prescribed herein for disposal as hazardous waste.
- 1) Lead Dust is present within the interiors of structures scheduled to be demolished. These structures will be cleaned of the dust before demolition of the structure.
- 2) Lead Dust waste that is collected during cleaning of the structures will be packaged and stored in a manner prescribed herein for disposal as hazardous waste.

5.1 Notifications

- 1) IRSE will make required notifications to the Department of Environmental Quality and submit these notifications to CWC before beginning work.

5.2 Work Area Preparation

5.2.1 Warning Signs – Asbestos Abatement

- 2) Danger signs meeting the specifications of OSHA Construction Safety Order, Section 1529 and WAC 296-62-077 will be posted at any location and approach where regulated areas are present. Signs will be posted at a distance sufficiently far enough away from the work areas to permit any employee or visitor to read the sign and take the necessary protective measures to avoid exposure. Warning signs shall include the following wording:

**DANGER
ASBESTOS
CANCER AND LUNG DISEASE HAZARD
AUTHORIZED PERSONNEL ONLY
RESPIRATORS AND PROTECTIVE CLOTHING
ARE REQUIRED IN THIS AREA**

- 2) These warning signs shall be printed in letters of sufficient size to be clearly legible.

5.2.2 Warning Signs- Lead Dust Abatement

- 3) Entrance by non-trained personnel into the lead paint removal area will be restricted using 3" barrier tape posted at the work area perimeter. Warning tape shall include the following wording:

**Danger Lead Removal
Authorized Personnel Only**

- 2) The warning tape shall be printed with letters of sufficient size to be clearly legible.

5.2.3 Electrical Power

- 1) The contractor will provide adequate power at each of the buildings. IRSE will provide temporary lighting sources and ensure safe installations (including ground faulting) of temporary power sources and equipment by complying with all applicable electrical code requirements and OSHA requirements for temporary electrical systems, within each building, as applies.

5.2.4 Establishing Asbestos Removal Work Areas

- 1) During indoor Class I removal of thermal system insulation, the wrap and cut method will be utilized. (HEPA) vacuums and wet methods will be utilized.
- 2) As applicable, IRSE will seal the exterior of the regulated areas. All windows, doors, and any other openings to the outside of the building from the regulated areas, will be sealed with a minimum of one layer of 6-mil poly sheeting with duct tape, until a negative exposure assessment is conducted.
- 3) During Class I removal of TSI using glovebag and wrap and cut methods with HEPA vacuum method procedures, the work area will be restricted using signs as described in 5.2.1. 6-mil poly will be installed on floors/ground in work area. Negative air machines may be installed in order to provide clean air from outside the work area at sufficient quantities and at strategic locations, so as to provide clean air in the workers' breathing zone, as described in Appendix D IRSE Hazardous Material Contractor Quality Control Plan.
- 4) During outdoor Class II removal of transite shingles and skirting, a single layer of 6-mil poly will be placed on the ground directly under the material to be removed, extending 10-20' out from the base of the building.
- 5) During outdoor Class II removal of metal siding, a single layer of 6-mil poly will be placed on the ground directly under the material to be removed, extending 10-20' out from the base of the building.
- 6) During Class II removal of floor covering, the work area will be restricted using signs as described in 5.2.1. 6-mil poly will be installed critical in the work area. Negative air machines will be installed in order to provide clean air from outside the work area at sufficient quantities and at strategic locations, so as to provide clean air in the workers' breathing zone, as described in Appendix D IRSE Hazardous Material Contractor Quality Control Plan.
- 7) During Class II removal of asbestos-containing roofing materials a single layer of 6-mil poly will be placed on the ground directly under the material to be removed, extending 10-20' out from the base of the building.
- 8) During Class II removal of window caulking, a single layer of 6-mil poly will be placed on the ground directly under the material to be removed, extending 5-10' out from the base of the building.

- 8) During removal of all Class II work, the area will be restricted using signs described in 5.2.1. Specific means and methods will be found in Appendix D.
- 6) 2" red "DANGER ASBESTOS - DO NOT ENTER" tape will be used to restrict access by untrained personnel.

5.2.5 Establishing Lead Dust Removal Work Areas

- 1) As applicable, IRSE will seal the exterior of the regulated areas. All windows, doors, and any other openings to the outside of the building from the regulated areas, will be sealed with a minimum of one layer of 6-mil poly sheeting with duct tape, until a negative exposure assessment is conducted.
- 2) 2" red "DANGER LEAD - DO NOT ENTER" tape will be used to restrict access by untrained personnel.

5.3 Workplace Entry and Exit Procedures – Asbestos and LEAD

- 1) IRSE will be using mobile trailer designed as a 3-stage worker decontamination unit, and a fixed worker decontamination unit (2- or 3-stage, depending on the scope of work at each individual work site) and locate it next to the entrance of the work area.
- 2) If the quantity of thermal system insulation exceeds 10 linear feet or 25 square feet, IRSE will construct a three-stage decontamination unit, including clean room, shower and dirty room, contiguous to the "regulated work area". If the quantity of ACM to be abated is less than 10 linear feet or 25 square feet, IRSE will construct a two-stage decontamination unit, including clean room and dirty room, contiguous to the "regulated work area". The procedures that will be used to enter decontamination units are described below.
- 3) Workers will enter the regulated work areas through the worker decontamination unit. The decontamination unit is a fully enclosed system.
- 4) These decontamination units will include an equipment or "dirty" room, a functional shower equipped with hot and cold running water (if necessary), and a changing or "clean" room in series. The decontamination units will also be constructed in such a manner as to provide a systematic reduction of contamination for the workers and equipment exiting the regulated work area. Personnel entry into and egress from the regulated work areas will be through the decontamination units. Equipment and material replenishment may also be conducted through the decontamination unit.
- 5) Wastewater resulting from the operation of the shower units shall be filtered with a 5-micron pore-size filtration system before reuse or discharge. To the extent feasible, filtered wastewater will be reclaimed and used on site for application in wet method work practices. Wastewater to be discharged shall be sufficiently filtered to meet state and local water quality objectives before discharge. Filters shall be changed as necessary to achieve this objective.

- 6) Before exiting the work area, personnel shall remove outer protective clothing and use a HEPA vacuum to remove ACM debris from protective clothing. Workers shall then proceed to move disposable clothing and dispose of it as hazardous waste. Non-disposable clothing (such as work boots) shall be decontaminated before being removed from the work area.

****Removing asbestos dust from protective clothing or equipment by blowing, shaking, or any other means that disperses asbestos fibers into the air shall likewise be prohibited.**

- 6) If applicable, workers exiting the regulated work areas will wash (shower) all areas of the body that were potentially exposed to asbestos contamination. Respirators shall continue to be worn by workers until the worker has entered the shower and begun to wash. Once the head has been deluged with water, the respirator may be removed. IRSE will supply workers with soap and shampoo to use in the showers.
- 7) A secure change room shall be provided outside the decontamination units and shall be equipped with storage for workers' street clothes and personal belongings. Workers are to change from street clothes each day before entering the regulated work area. Workers are to change back into street clothes each day before leaving the work site. Personnel are prohibited from wearing potentially contaminated clothing off the site. Housekeeping within the change room will be maintained by IRSE. Periodic area air monitoring will be conducted to evaluate housekeeping efforts.
- 8) Waste containers shall also be decontaminated using HEPA vacuums and by wet wiping before being removed from the work areas.
- 9) In the event an emergency egress from within the regulated work is required, the above-described personnel decontamination procedures will not be required. IRSE will exercise judgment to ensure that worker health and safety is placed above environmental contamination concerns.
- 10) In those instances when it is not feasible to provide shower facilities contiguous with the work area or where the work is performed outdoors, the Contractor shall ensure that employees remove (1) asbestos contamination from their worksuits in the equipment room utilizing a HEPA vacuum before proceeding to a shower that is not adjacent to the work area, or (2) their contaminated worksuits in the equipment room, don a clean worksuit, and proceed to a shower that is not adjacent to the work area. A second inner disposable/breathable Tyvek whole-body coverall may be utilized by workers for modesty's sake under the primary outer worksuit. The outer suit will be cleaned using a HEPA vacuum and removed within the isolated work area.
- 11) The containment design and decontamination unit that will be utilized for each work area will be dependent on the DEQ asbestos work classification.

5.4 Personal Protective Equipment

- 1) Except when more stringent requirements are set forth, the personal protective equipment (PPE) utilized during the conduct of this work must meet or exceed the requirements contained in Title 29 CFR 1926.1101.

5.4.1 Respiratory Protection

- 1) Half-face negative pressure respirators (equipped with HEPA filters) will be utilized for Class I and II materials being removed on this project. Protective glasses or goggles worn by workers will conform to the specifications of the ANSI Z87.1 standard of Title 29 CFR §1910.133.
- 2) Half-face negative pressure respirators (equipped with HEPA filters) will be worn by all personnel working within Lead Dust Removal Work Areas.
- 3) Once a negative pressure enclosure (if applies) has been visually inspected and placed under a negative air pressure differential, full-faced supplied air respirators operated in constant flow or pressure demand mode and equipped with HEPA escape filters, will be worn by workers, supervisors, work monitors, industrial hygienists, and other entering the regulated work area.
- 3) During outdoor Class II removal of materials, half-face negative pressure respirators equipped with HEPA filters will be used.
- 4) During indoor Class II removal of all materials identified, half-face negative pressure respirators equipped with HEPA filters will be used.
- 5) All respirators shall be used in a manner consistent with state-of-the-industry practices. The respirators shall be worn with head straps in direct contact with the head and shall not be worn on the outside of the hoods of disposable whole-body coveralls. An exception to this is allowable in those instances when a remote decontamination unit is being utilized and the worker is double suited. Respirators shall be worn until proper personal decontamination methods, as described herein, are completed.
- 6) The Contractor will provide respirators in accordance OSHA 1019.133 Respirator Protection

5.4.2 Whole Body Protection

- 1) Work boots with nonskid soles or impermeable work-boot covers shall be worn by workers. Protective footwear worn by workers shall conform to the specifications of the ASNI Z41.1 standard. Work boots that have come into contact with contaminated material shall be cleaned, decontaminated, and bagged before removal from the work area.
- 2) Protective head gear (hard hats) shall be worn at all times that work is in progress. Protective head gear worn by workers shall conform to the specifications of the ANSI Z89.1 (Class A) standard. Hard hats shall be thoroughly decontaminated before removing from the work area.

- 3) In work areas where excessive noise is prevalent, worker shall wear hearing protection sufficient to ensure that the worker's 8-hour time-weighted average (TWA) exposure does not exceed 85 Dba.
- 4) IRSE will make available extra sets of PPE to be used by the owners authorized representative for use to enter the regulated work areas.

5.5 Asbestos Removal Techniques and Procedures

- 1) For the purposes of this work plan, the removal of ACM thermal system insulation (TSI) or ACM surfacing materials will be considered "Class I Asbestos Work," as defined by OSHA Title 29 CFR 1926.1101 and shall be conducted in accordance with work practices and requirements set forth for Class I work.
- 2) IRSE will conduct the construction activities described herein in accordance with all currently applicable federal, state, and local laws and regulations including, but not limited to, Title 29 CFR 1926.1101.
- 3) All asbestos-containing material thermal system insulation will be removed via the glovebag method or glovebag and wrap and cut method, with negative air ventilation procedures.

5.5.1 Removal of ACM Thermal System Insulation from Buildings

- 5) IRSE will then pre-clean the work area. This will entail cleaning of any visible asbestos debris and dirt which may affect area and clearance air monitoring. Following pre-cleaning, IRSE will begin installing glovebags on the pipes which have been determined to contain asbestos-containing thermal system insulation.
- 6) The IRSE Competent Person will then conduct visual inspections and smoke testing on the glovebags and ensure that all necessary tools are present, including Hudson sprayers, waste bags, and a HEPA vacuum.
- 7) Only after satisfactory visual inspections from the IRSE Competent Person will the go ahead to begin asbestos removal be given.
- 8) All glovebagging will be conducted in two-man crews. One worker will remove the asbestos-containing pipe insulation inside the glovebag while the other worker constantly mists the insulation with amended water.
- 9) Once the ACM insulation has been removed from the pipe and is on the bottom of the glovebag, the pipe and top inside portion of the glovebag will be wet wiped clean. IRSE will twist the bag several times and tape it to keep the ACM in the bottom during removal of the glovebag from the pipe. A HEPA vacuum should be used to evacuate air out of the glovebag.
- 10) A 6-mil disposal bag will be slipped over the glovebag (while still attached to the pipe). The tape holding glovebag to pipe will then be removed and the top of glovebag opened then folded down into waste bag.

- 11) Following an acceptable visual inspection from the CWC Site Safety Officer, IRSE will apply an encapsulant to all surfaces in the work area and clearance sampling can be collected for analysis.

5.5.2 Outdoor Removal of Transite Shingles and Metal Siding

- 1) The workers will don appropriate PPE as described in Section 5.4.
- 2) IRSE will perform setup of the work area as described in Section 5.2.3(3).
- 3) IRSE will notify the on-site Safety Officer prior to beginning removal so that visual inspections can be conducted to insure that all necessary tools are available, including water, HEPA vacuum, lined dumpster.
- 4) After satisfactory visual inspection by the Safety Officer, IRSE will begin transite removal.
- 5) Transite removal will be conducted using methods described in the IRSE Hazardous Material Contractor Quality Control Plan.

5.5.3 Removal of all other Class II Materials

- 1) The workers will don appropriate PPE as described in Section 5.4.
- 2) IRSE will perform setup of the work area as described in Section 5.2.3(7).
- 3) IRSE will notify the on-site Safety Officer prior to beginning removal so that visual inspections can be conducted to insure that all necessary tools are available, including water, HEPA vacuum, lined dumpster.
- 4) After satisfactory visual inspection by the Safety Officer, IRSE will begin removal of specific materials, as identified in Appendix D.
- 5) Class II removal will be conducted using methods described in the IRSE Hazardous Material Contractor Quality Control Plan.

5.5.4 Final Visual Inspection of Work Area

- 1) Following an acceptable visual inspection by the CWC Site Safety Officer after asbestos removal from each asbestos removal work area, IRSE will apply an encapsulant to all surfaces in the work area and clearance sampling can be collected for analysis.
- 2) All abated areas will be inspected by the Contractor, CWC Onsite Supervisor and IRSE supervisor. Upon successful inspection, each will sign the completed form "*Final Inspection Report*" Form. The Form can be found at the end of Attachment C: Forms.

5.6 Removal of Lead Dust from Buildings

- 1) IRSE will conduct the construction activities described herein in accordance with all currently applicable federal, state, and local laws and regulations including, but not limited to, Title 29 CFR 1019.10025.

5.6.1 Vacuuming Lead dust in Building

- 1) The workers will don appropriate PPE as stated in Section 5.4 and IRSE Hazardous Material Quality Control Plan.
- 2) IRSE will then perform setup of the "Lead Removal Work Area" as stated in Section 5.2.4. (1), including installing critical barriers.
- 3) IRSE will also install a two stage decontamination unit as stated in Section 5.3. The decontamination unit will be placed at the doorway leading into the building or at a central area on site.
- 4) Once the decontamination unit and all critical seals have been installed, the IRSE Competent Person will perform a visual inspection of the work area to ensure that all critical seals are in place and that adequate negative pressure has been established, if applies.
- 4) All abated areas will be inspected by the Contractor, CWC Onsite Supervisor and IRSE supervisor. Upon successful inspection, each will sign the completed form "*Final Inspection Report*" Form. The Form can be found at the end of Attachment C: Forms.

6.0 Waste Handling and Disposal

6.1 Packaging and Storage of Waste and Removal from the Work Area

- 1) The friable ACMs that will be removed from the project site and are judged by a competent person to be friable (i.e., those ACMs that, when dry, can be crushed, crumbled, pulverized, or otherwise rendered to a dust by hand pressure) will be packaged and stored in a manner prescribed herein for disposal as hazardous waste.
- 2) Friable asbestos waste shall be placed in two layers of 6-mil polyethylene disposal bags.
- 3) All friable asbestos waste (bagged) will exit the work area through the equipment room of the decontamination unit or from a separate waste load out decontamination unit. These waste loads out units will be contiguous to the work area containment.
- 4) The personnel loading the asbestos-containing waste will be protected by disposable clothing and, at a minimum, half-facepiece air-purifying dual-cartridge respirators equipped with high efficiency filters.
- 5) The bagged or wrapped asbestos waste shall be properly labeled and placed in locked storage containers. At a minimum, the outside of each waste bag or package containing asbestos hazardous waste will be labeled as described in 6.2(5).

6.2 Packaging and Storage of Nonfriable Waste and Removal from the Work Area

- 1) The nonfriable ACMs that will be removed from the project site and are judged by a competent person to be nonfriable (i.e., those ACMs that, when dry, cannot be crushed, crumbled, pulverized, or otherwise rendered to a dust by hand pressure) will be packaged and stored in a manner prescribed herein for disposal as hazardous waste.
- 2) Nonfriable asbestos waste will be loaded directly into a mega boxes, (Gaylord boxes) place in disposal bags and doubled bagged or double wrapped with 6 mil poly.
- 3) The personnel loading the asbestos-containing waste will be protected by disposable clothing and, at a minimum, half-facepiece air-purifying dual-cartridge respirators equipped with high efficiency filters.
- 5) The wrapped asbestos waste shall be properly labeled and placed in locked storage containers. At a minimum, the outside of each package containing asbestos hazardous waste will be labeled as follows:

**DANGER
CONTAINS ASBESTOS FIBERS
AVOID CREATING DUST
CANCER AND LUNG DISEASE HAZARD
HAZARDOUS WASTE
STATE AND FEDERAL LAW
PROHIBITS IMPROPER DISPOSAL
IF FOUND, CONTACT THE NEAREST POLICE OR PUBLIC SAFETY
AUTHORITY OF THE WASHINGTON DEPARTMENT OF
TOXIC SUBSTANCES CONTROL**

Generator's Name _____

Address _____

Manifest _____

RQ, Asbestos, 9, NA2212, III

- 6) The asbestos disposal containers (e.g., bags, wraps and boxes) and storage areas shall be secured and placarded with appropriate warning signage

6.3 Transportation and Disposal

- 1) The disposal of waste that contains asbestos waste and lead waste will stay onsite and be placed in a storage area designated by the General Contractor.

7.0 Air Monitoring Sampling

7.1 Personal Air Monitoring – Asbestos

- 1) IRSE's Competent Person will be conducting personal air monitoring on workers involved in the project. Personal air monitoring for asbestos will be conducted in accordance with Title 29 CFR 1926.1101. The IRSE Competent Person shall use the personal air monitoring results to evaluate the effectiveness of engineering controls and the adequacy of PPE and to determine whether the appropriate work practices are being utilized.
- 2) Personal exposure monitoring for asbestos shall be conducted utilizing single-use standard 25-mm-diameter, 0.8 -micron pore size, MCE membrane filters and cassettes with nonconductive cowlings ("barrels") and shrink bands. Air samples for asbestos concentrations will be analyzed by PCM Method 7400/7402.
- 3) The Contractor's workers shall not be exposed to an airborne fiber concentration in excess of 1.0 fiber per cubic centimeter (f/cc) as averaged over a sampling period of 30 minutes nor in excess of 0.1f/cc as expressed as an 8-hour TWA.
- 4) The Contractor will post the results of daily personal air monitoring at the job site.

7.2 Pre-abatement, Area and Perimeter Sampling – Asbestos

- 1) Except as otherwise noted, environmental sampling for airborne asbestos shall be conducted utilizing single-use, standard 25-millimeter-diameter, 0.8-micron pore size, mixed MCE membrane filters and cassettes with nonconductive cowlings ("barrels") and shrink bands. Air samples for asbestos concentrations will be analyzed by PM Method 7400.
- 2) IRSE Competent Person shall conduct daily environmental air sampling for airborne fiber concentrations outside the regulated asbestos work areas. A minimum of two samples will be collected outside each Class I negative pressure enclosure abatement activities.
- 3) Pre-abatement (baseline or background) air sampling will also be conducted by IRSE's supervisor. These samples will be collected in general accordance with 29 CFR 1926.1101, although the number of samples collected per location will vary. Air samples for baseline asbestos fiber concentrations will be analyzed by PCM Method 7400. Pre-abatement air samples will be collected by "nonaggressive" methods.

7.3 Final Cleaning, Clearance Sampling Methodology and Analysis – Asbestos

- 1) Visual inspections and air clearance sampling of each work area shall be conducted by an independent contractor hired by the owner/general contractor. Following the completion of asbestos abatement and final detail cleaning in each work area. The cleaning phase will include misting the air with amended water to reduce airborne fiber concentrations. The cleaning process shall also include vacuuming with HEPA-equipped vacuums and wet wiping. Horizontal surfaces within the area shall be cleaned of all visible asbestos debris using a HEPA vacuum and wet wiped.

If a visual inspection reveals residual three-dimensional debris, IRSE will abate the debris, detail clean the area of the debris, and repeat the HEPA vacuum and wet wiping process. Once the recleaning process is complete, the work area shall be subject to another visual inspection for the presence of residual three-dimensional debris.

- 2) Satisfactory completion of this visual inspection will be followed by the encapsulation of the substrates and/or systems from which the ACM was removed. Following a suitable period of time to allow the encapsulant to dry, final air clearance samples will be collected. Clearance air samples will be collected using the methods described herein. Negative pressure equipment (NPE), if applicable, will continue in operation until satisfactory clearance air sample results are achieved. Failure to achieve satisfactory air clearance results will result in IRSE repeating the final cleaning process and the subsequent collection of additional clearance air samples.
- 3) Collection and analysis of clearance air sample monitoring for asbestos hazard abatement will be an independent industrial hygiene provider under contract with the owner/general contractor. Collection and analysis of clearance work areas after the ACM hazard has been abated and the work area has passed a visual clearance
- 4) Five or more samples will be collected within each containment. Clearance air samples indicating airborne fiber concentrations within the requirements of AHERA Guidelines for asbestos response action activities in schools will be received, and written permission from Northern Industrial Hygiene will be obtained before releasing IRSE to demobilize the work area.
- 5) Once a work area has been abated of ACM hazards, satisfactory final air clearance testing has been concluded and written permission from Northern Industrial Hygiene has been obtained, any remaining layers of polyethylene sheeting shall be removed and disposed of as asbestos waste

7.4 Personnel Air Monitoring – Lead

- 1) IRSE's Competent Person Supervisor will be conducting personal air monitoring on workers involved in the project. Personal air monitoring for lead will be conducted in accordance with Title 29 CFR 1926.62. The IRSE Supervisor shall use the personal air monitoring results to evaluate the effectiveness of engineering controls and the adequacy of PPE and to determine whether the appropriate work practices are being utilized.2) Personal exposure monitoring for lead shall be conducted utilizing single-use standard 37-mm-diameter, 0.8 -micron pore size, MCEF membrane filters and cassettes with nonconductive cowlings ("barrels").
- 3) The Contractor's workers shall not be exposed to airborne lead in concentrations over $15\mu\text{g}/\text{m}^3$ (half of the action level) as expressed as an 8-hour TWA. If airborne concentrations of lead in the breathing zone of any individual employee reaches $10\mu\text{g}/\text{m}^3$, work will stop and the Northern Management Services Project Manager will be notified. Engineering controls will be re-evaluated and additional engineering controls will be implemented before work resumes.

- 4) The Contractor will post the results of daily personal air monitoring at the job site within 72 hours of air sample collection.

7.5 Area and Perimeter Sampling - Lead

- 1) The IRSE Supervisor shall use the personal air monitoring results to evaluate the effectiveness of engineering controls and the adequacy of PPE and to determine whether the appropriate work practices are being utilized.
- 2) Monitoring for lead shall be conducted utilizing single-use standard 37-mm-diameter, 0.8-micron pore size, MCEF membrane filters and cassettes with nonconductive cowlings ("barrels").
- 4) IRSE's Supervisor will collect air samples prior (baseline or background) to LBP removal. These samples will be collected for information and documentation only, and are not required by contract documents or regulation.

8.0 Laboratory Analysis of Personal Air Samples

- 1) All personal and OWA air samples will be analyzed at Mountain Labs, Inc.. This lab is an American Industrial Hygiene Association (AIHA) and an EPA National Voluntary Laboratory Accreditation Program (NVLAP) accredited laboratory.
- 2) All air samples for asbestos concentration will be analyzed by PCM Method 7400/7402.

APPENDIX D

FUMED SLAG ANALYTICAL DATA

ANALYTICAL SUMMARY REPORT

May 02, 2005

Iver Johnson

MT DEQ

PO Box 200901

Helena, MT 59620

COPY

RECEIVED

MAY 05 2005

Dept. of Enviro. Quality
Waste & Underground
Tank Management Bureau

Workorder No.: H05040130

Project Name: ASARCO Slag Pile

Energy Laboratories Inc received the following 10 samples from MT DEQ on 4/14/2005 for analysis.

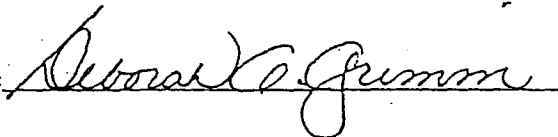
Sample ID	Client Sample ID	Collect Date	Receive Date	Matrix	Test
H05040130-001	ASP01-B3	04/14/05 14:15	04/14/05	Solid	Metals by ICP/ICPMS, Total Mercury in Solid By CVAA Digestion, Total Metals Digestion, Mercury by CVAA
H05040130-002	ASP02-B5	04/14/05 14:21	04/14/05	Solid	Same As Above
H05040130-003	ASP03-B14	04/14/05 14:28	04/14/05	Solid	Metals by ICP/ICPMS, Total Chloride, Sulfate Mercury in Solid By CVAA Moisture Moisture Polychlorinated Biphenyls (PCB's) pH Digestion, Total Metals Digestion, Mercury by CVAA Saturated Paste Extraction Sonication Extraction Soil Sonication Extraction Semi-Volatile Organic Compounds, PAHs Volatile Organics, Methanol Extraction 8260-Volatile Organic Compounds - Short List
H05040130-004	ASP04-C4	04/14/05 14:37	04/14/05	Solid	Metals by ICP/ICPMS, Total Mercury in Solid By CVAA Digestion, Total Metals Digestion, Mercury by CVAA
H05040130-005	ASP05-C9	04/14/05 14:44	04/14/05	Solid	Metals by ICP/ICPMS, Total Chloride, Sulfate Mercury in Solid By CVAA Moisture Moisture Polychlorinated Biphenyls (PCB's) pH Digestion, Total Metals Digestion, Mercury by CVAA Saturated Paste Extraction Sonication Extraction Soil Sonication Extraction Semi-Volatile Organic Compounds, PAHs Volatile Organics, Methanol Extraction 8260-Volatile Organic Compounds - Short List

H05040130-006	ASP06-D16	04/14/05 14:50 04/14/05	Solid	Metals by ICP/ICPMS, Total Mercury in Solid By CVAA Digestion, Total Metals Digestion, Mercury by CVAA
H05040130-007	ASP07-F3	04/14/05 14:57 04/14/05	Solid	Same As Above
H05040130-008	ASP08-G2	04/14/05 15:04 04/14/05	Solid	Metals by ICP/ICPMS, Total Chloride, Sulfate Mercury in Solid By CVAA Moisture Moisture Polychlorinated Biphenyls (PCB's) pH Digestion, Total Metals Digestion, Mercury by CVAA Saturated Paste Extraction Sonication Extraction Soil Sonication Extraction Semi-Volatile Organic Compounds, PAHs Volatile Organics, Methanol Extraction 8260-Volatile Organic Compounds - Short List
H05040130-009	ASP09-G4	04/14/05 15:07 04/14/05	Solid	Metals by ICP/ICPMS, Total Mercury in Solid By CVAA Digestion, Total Metals Digestion, Mercury by CVAA
H05040130-010	ASP10-H16	04/14/05 15:15 04/14/05	Solid	Same As Above

There were no problems with the analyses and all data for associated QC met EPA or laboratory specifications except where noted in the Case Narrative or Report.

If you have any questions regarding these tests results, please call.

Report Approved By:



Client: MT DEQ
 Project: ASARCO Slag Pile
 Lab ID: H05040130-001
 Client Sample ID: ASP01-B3

Report Date: 05/02/05
 Collection Date: 04/14/05 14:15
 Date Received: 04/14/05
 Matrix: Solid

Analyses	Result	Units	Qual	MCL/		Method	Analysis Date / By
				RL	QCL		
METALS, TOTAL							
Antimony	34.9	mg/kg		5.0		SW6020	04/27/05 00:49 / rth
Arsenic	130	mg/kg		5.0		SW6020	04/27/05 00:49 / rth
Beryllium	ND	mg/kg		5.0		SW6010B	04/22/05 03:48 / jjw
Cadmium	3.1	mg/kg		1.0		SW6010B	04/20/05 19:24 / jjw
Chromium	60.8	mg/kg		5.0		SW6010B	04/20/05 19:24 / jjw
Cobalt	164	mg/kg		5.0		SW6010B	04/20/05 19:24 / jjw
Iron	196000	mg/kg	D	40		SW6010B	04/20/05 19:28 / jjw
Lead	134	mg/kg		5.0		SW6010B	04/20/05 19:28 / jjw
Manganese	11400	mg/kg		5.0		SW6010B	04/22/05 03:48 / jjw
Mercury	ND	mg/kg		1.0		SW7471A	04/25/05 13:51 / KC
Nickel	8.4	mg/kg		5.0		SW6010B	04/20/05 19:24 / jjw
Phosphorus	652	mg/kg		10		SW6010B	04/22/05 03:48 / jjw
Selenium	6.4	mg/kg		5.0		SW6020	04/27/05 00:49 / rth
Zinc	13200	mg/kg		5.0		SW6010B	04/20/05 19:28 / jjw

Report RL - Analyte reporting limit.

Definitions: QCL - Quality control limit.

D - RL increased due to sample matrix interference.

MCL - Maximum contaminant level.

ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Client: MT DEQ
 Project: ASARCO Slag Pile
 Lab ID: H05040130-002
 Client Sample ID: ASP02-B5

Report Date: 05/02/05
 Collection Date: 04/14/05 14:21
 Date Received: 04/14/05
 Matrix: Solid

Analyses	Result	Units	Qual	MCL/		Method	Analysis Date / By
				RL	QCL		
METALS, TOTAL							
Antimony	46.7	mg/kg		5.0		SW6020	04/27/05 00:56 / rlh
Arsenic	135	mg/kg		5.0		SW6020	04/27/05 00:56 / rlh
Beryllium	ND	mg/kg		5.0		SW6010B	04/22/05 03:51 / jjw
Cadmium	4.1	mg/kg		1.0		SW6010B	04/20/05 19:32 / jjw
Chromium	59.4	mg/kg		5.0		SW6010B	04/20/05 19:32 / jjw
Cobalt	207	mg/kg		5.0		SW6010B	04/20/05 19:32 / jjw
Iron	243000	mg/kg	D	80		SW6010B	04/22/05 03:51 / jjw
Lead	140	mg/kg		5.0		SW6010B	04/20/05 19:32 / jjw
Manganese	11700	mg/kg		5.0		SW6010B	04/22/05 03:51 / jjw
Mercury	ND	mg/kg		1.0		SW7471A	04/25/05 13:57 / KC
Nickel	20.4	mg/kg		5.0		SW6020	04/27/05 00:56 / rlh
Phosphorus	584	mg/kg		10		SW6010B	04/22/05 03:51 / jjw
Selenium	8.5	mg/kg		5.0		SW6020	04/27/05 00:56 / rlh
Zinc	16900	mg/kg		5.0		SW6010B	04/22/05 03:51 / jjw

Report Definitions: RL - Analyte reporting limit.
 QCL - Quality control limit.
 D - RL increased due to sample matrix interference.

MCL - Maximum contaminant level.
 ND - Not detected at the reporting limit.

Client: MT DEQ
 Project: ASARCO Slag Pile
 Lab ID: H05040130-003
 Client Sample ID: ASP03-B14

Report Date: 05/02/05
 Collection Date: 04/14/05 14:28
 Date Received: 04/14/05
 Matrix: Solid

Analyses	Result	Units	Qual	MCL/		Method	Analysis Date / B
				RL	QCL		
PHYSICAL CHARACTERISTICS							
Moisture	0.500	wt%		0.0100		SW3550A	04/22/05 08:15 / MC
CHEMICAL CHARACTERISTICS							
pH, 1:2	8.6	s.u.		0.1		ASA10-3	04/25/05 16:18 / srr
Chloride, 1:2	1.99	mg/kg		1.00		ASA10-3	04/26/05 11:49 / qec
METALS, TOTAL							
Antimony	33.7	mg/kg		5.0		SW6020	04/27/05 01:03 / rth
Arsenic	118	mg/kg		5.0		SW6020	04/27/05 01:03 / rth
Beryllium	ND	mg/kg		5.0		SW6010B	04/22/05 04:02 / jjw
Cadmium	2.6	mg/kg		1.0		SW6010B	04/20/05 19:35 / jjw
Chromium	67.1	mg/kg		5.0		SW6010B	04/20/05 19:35 / jjw
Cobalt	117	mg/kg		5.0		SW6010B	04/20/05 19:35 / jjw
Iron	264000	mg/kg	D	80		SW6010B	04/22/05 04:02 / jjw
Lead	63.8	mg/kg		5.0		SW6010B	04/20/05 19:35 / jjw
Manganese	13200	mg/kg		5.0		SW6010B	04/22/05 04:02 / jjw
Mercury	ND	mg/kg		1.0		SW7471A	04/25/05 13:59 / KC
Nickel	14.5	mg/kg		5.0		SW6020	04/27/05 01:03 / rth
Phosphorus	612	mg/kg		10		SW6010B	04/22/05 04:02 / jjw
Selenium	8.4	mg/kg		5.0		SW6020	04/27/05 01:03 / rth
Zinc	13500	mg/kg		5.0		SW6010B	04/22/05 04:02 / jjw
VOLATILE ORGANIC COMPOUNDS							
Bromoform	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
Benzene	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
Bromobenzene	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
Bromochloromethane	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
Bromodichloromethane	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
Bromomethane	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
Carbon tetrachloride	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
Chlorobenzene	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
Chloroethane	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
2-Chloroethyl vinyl ether	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
Chloroform	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
Chloromethane	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
2-Chlorotoluene	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
4-Chlorotoluene	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
Chlorodibromomethane	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
1,2-Dibromoethane	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
Dibromomethane	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
1,2-Dichlorobenzene	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr

Report RL - Analyte reporting limit.
 Definitions: QCL - Quality control limit.
 D - RL increased due to sample matrix interference.

MCL - Maximum contaminant level.
 ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Client: MT DEQ
 Project: ASARCO Slag Pile
 Lab ID: H05040130-003
 Client Sample ID: ASP03-B14

Report Date: 05/02/05
 Collection Date: 04/14/05 14:28
 Date Received: 04/14/05
 Matrix: Solid

Analyses	Result	Units	Qual	MCL/		Method	Analysis Date / By
				RL	QCL		
VOLATILE ORGANIC COMPOUNDS							
1,3-Dichlorobenzene	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
1,4-Dichlorobenzene	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
Dichlorodifluoromethane	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
1,1-Dichloroethane	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
1,2-Dichloroethane	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
cis-1,2-Dichloroethene	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
1,1-Dichloroethene	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
trans-1,2-Dichloroethene	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
1,2-Dichloropropane	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
1,3-Dichloropropane	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
2,2-Dichloropropane	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
1,1-Dichloropropene	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
cis-1,3-Dichloropropene	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
trans-1,3-Dichloropropene	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
Ethylbenzene	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
Methyl tert-butyl ether (MTBE)	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
Methylene chloride	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
Methyl ethyl ketone	ND	mg/kg		4.0		SW8260B	04/21/05 16:42 / trr
Styrene	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
1,1,1,2-Tetrachloroethane	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
1,1,2,2-Tetrachloroethane	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
Tetrachloroethene	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
Toluene	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
1,1,1-Trichloroethane	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
1,1,2-Trichloroethane	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
Trichloroethene	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
Trichlorofluoromethane	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
1,2,3-Trichloropropane	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
Vinyl chloride	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
m+p-Xylenes	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
o-Xylene	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
Surr: p-Bromofluorobenzene	134	%REC			76-160	SW8260B	04/21/05 16:42 / trr
Surr: Dibromofluoromethane	116	%REC			70-132	SW8260B	04/21/05 16:42 / trr
Surr: 1,2-Dichloroethane-d4	114	%REC			60-136	SW8260B	04/21/05 16:42 / trr
Surr: Toluene-d8	120	%REC			75-138	SW8260B	04/21/05 16:42 / trr
SEMI-VOLATILE ORGANIC COMPOUNDS							
Acenaphthene	ND	mg/kg		0.33		SW8270C	04/21/05 13:56 / sm
Acenaphthylene	ND	mg/kg		0.33		SW8270C	04/21/05 13:56 / sm
Anthracene	ND	mg/kg		0.33		SW8270C	04/21/05 13:56 / sm
Benzo(a)anthracene	ND	mg/kg		0.33		SW8270C	04/21/05 13:56 / sm

Report: RL - Analyte reporting limit.
 Definitions: QCL - Quality control limit.

MCL - Maximum contaminant level.
 ND - Not detected at the reporting limit.

Client: MT DEQ
 Project: ASARCO Slag Pile
 Lab ID: H05040130-003
 Client Sample ID: ASP03-B14

Report Date: 05/02/05
 Collection Date: 04/14/05 14:28
 Date Received: 04/14/05
 Matrix: Solid

Analyses	Result	Units	Qual	MCL/		Method	Analysis Date / B
				RL	QCL		
SEMI-VOLATILE ORGANIC COMPOUNDS							
Benzo(a)pyrene	ND	mg/kg		0.33		SWS270C	04/21/05 13:56 / sm
Benzo(b)fluoranthene	ND	mg/kg		0.33		SW8270C	04/21/05 13:56 / sm
Benzo(g,h,i)perylene	ND	mg/kg		0.33		SWS270C	04/21/05 13:56 / sm
Benzo(k)fluoranthene	ND	mg/kg		0.33		SW8270C	04/21/05 13:56 / sm
Chrysene	ND	mg/kg		0.33		SWS270C	04/21/05 13:56 / sm
Dibenzo(a,h)anthracene	ND	mg/kg		0.33		SWS270C	04/21/05 13:56 / sm
Fluoranthene	ND	mg/kg		0.33		SW8270C	04/21/05 13:56 / sm
Fluorene	ND	mg/kg		0.33		SW8270C	04/21/05 13:56 / sm
Indeno(1,2,3-cd)pyrene	ND	mg/kg		0.33		SW8270C	04/21/05 13:56 / sm
Naphthalene	ND	mg/kg		0.33		SW8270C	04/21/05 13:56 / sm
Phenanthrene	ND	mg/kg		0.33		SWS270C	04/21/05 13:56 / sm
Pyrene	ND	mg/kg		0.33		SW8270C	04/21/05 13:56 / sm
Surr: 2-Fluorobiphenyl	82.5	%REC			30-115	SW8270C	04/21/05 13:56 / sm
Surr: Nitrobenzene-d5	83.7	%REC			23-120	SW8270C	04/21/05 13:56 / sm
Surr: Terphenyl-d14	98.6	%REC			18-137	SW8270C	04/21/05 13:56 / sm
POLYCHLORINATED BIPHENYLS (PCB'S)							
Aroclor 1016	ND	mg/kg		0.017		SW8022	04/24/05 03:13 / law
Aroclor 1221	ND	mg/kg		0.017		SW8022	04/24/05 03:13 / law
Aroclor 1232	ND	mg/kg		0.017		SW8022	04/24/05 03:13 / law
Aroclor 1242	ND	mg/kg		0.017		SW8022	04/24/05 03:13 / law
Aroclor 1248	ND	mg/kg		0.017		SW8022	04/24/05 03:13 / law
Aroclor 1254	ND	mg/kg		0.017		SW8022	04/24/05 03:13 / law
Aroclor 1260	ND	mg/kg		0.017		SW8022	04/24/05 03:13 / law
Aroclor 1262	ND	mg/kg		0.017		SW8022	04/24/05 03:13 / law
Aroclor 1268	ND	mg/kg		0.017		SW8022	04/24/05 03:13 / law
Surr: Decachlorobiphenyl	96.0	%REC			50-126	SW8022	04/24/05 03:13 / law
Surr: Tetrachloro-m-xylene	86.0	%REC			42-115	SW8022	04/24/05 03:13 / law
Sample extract received a Sulfuric Acid Clean-up (EPA Method 3665) and a Sulfur Clean-up (EPA Method 3650) prior to analysis							

Sample extract received a Sulfuric Acid Clean-up (EPA Method 3665) and a Sulfur Clean-up (EPA Method 3660) prior to analysis.

Report RL - Analyte reporting limit.
 Definitions: QCL - Quality control limit.

MCL - Maximum contaminant level.
 ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Client: MT DEQ
 Project: ASARCO Slag Pile
 Lab ID: H05040130-004
 Client Sample ID: ASP04-C4

Report Date: 05/02/05
 Collection Date: 04/14/05 14:37
 Date Received: 04/14/05
 Matrix: Solid

Analyses	Result	Units	Qual	MCL/		Method	Analysis Date / B
				RL	QCL		
METALS, TOTAL							
Antimony	43.5	mg/kg		5.0		SW6020	04/27/05 01:10 / rth
Arsenic	155	mg/kg		5.0		SW6020	04/27/05 01:10 / rth
Beryllium	ND	mg/kg		5.0		SW6010B	04/22/05 04:06 / jjw
Cadmium	5.1	mg/kg		1.0		SW6010B	04/20/05 19:39 / jjw
Chromium	71.2	mg/kg		5.0		SW6010B	04/20/05 19:39 / jjw
Cobalt	212	mg/kg		5.0		SW6010B	04/20/05 19:39 / jjw
Iron	273000	mg/kg	D	80		SW6010B	04/22/05 04:06 / jjw
Lead	364	mg/kg		5.0		SW6010B	04/20/05 19:39 / jjw
Manganese	12200	mg/kg		5.0		SW6010B	04/22/05 04:06 / jjw
Mercury	ND	mg/kg		1.0		SW7471A	04/25/05 14:01 / KC
Nickel	22.9	mg/kg		5.0		SW6020	04/27/05 01:10 / rth
Phosphorus	586	mg/kg		10		SW6010B	04/22/05 04:06 / jjw
Selenium	12.1	mg/kg		5.0		SW6020	04/27/05 01:10 / rth
Zinc	17900	mg/kg		5.0		SW6010B	04/22/05 04:06 / jjw

Report: RL - Analyte reporting limit.
 Definitions: QCL - Quality control limit.
 D - RL increased due to sample matrix interference.

MCL - Maximum contaminant level.
 ND - Not detected at the reporting limit.

Client: MT DEQ
 Project: ASARCO Slag Pile
 Lab ID: H05040130-005
 Client Sample ID: ASP05-C9

Report Date: 05/02/05
 Collection Date: 04/14/05 14:44
 Date Received: 04/14/05
 Matrix: Solid

Analyses	Result	Units	Qual	MCL/		Method	Analysis Date / By
				RL	QCL		
PHYSICAL CHARACTERISTICS							
Moisture	0.800	wt%		0.0100		SW3550A	04/22/05 08:15 / MC
CHEMICAL CHARACTERISTICS							
pH, 1:2	9.0	s.u.		0.1		ASA10-3	04/25/05 16:18 / s:rm
Chloride, 1:2	2.89	mg/kg		1.00		ASA10-3	04/26/05 12:13 / qed
METALS, TOTAL							
Antimony	37.1	mg/kg		5.0		SW6020	04/27/05 01:44 / rth
Arsenic	117	mg/kg		5.0		SW6020	04/27/05 01:44 / rth
Beryllium	ND	mg/kg		5.0		SW6010B	04/22/05 04:13 / jjw
Cadmium	3.1	mg/kg		1.0		SW6010B	04/20/05 19:42 / jjw
Chromium	74.4	mg/kg		5.0		SW6010B	04/20/05 19:42 / jjw
Cobalt	153	mg/kg		5.0		SW6010B	04/20/05 19:42 / jjw
Iron	252000	mg/kg	D	80		SW6010B	04/22/05 04:13 / jjw
Lead	160	mg/kg		5.0		SW6010B	04/20/05 19:42 / jjw
Manganese	11800	mg/kg		5.0		SW6010B	04/22/05 04:13 / jjw
Mercury	ND	mg/kg		1.0		SW7471A	04/25/05 14:04 / KC
Nickel	15.9	mg/kg		5.0		SW6020	04/27/05 01:44 / rth
Phosphorus	707	mg/kg		10		SW6010B	04/22/05 04:13 / jjw
Selenium	12.7	mg/kg		5.0		SW6020	04/27/05 01:44 / rth
Zinc	18500	mg/kg		5.0		SW6010B	04/22/05 04:13 / jjw
VOLATILE ORGANIC COMPOUNDS							
Bromoform	ND	mg/kg		0.20		SW8250S	04/21/05 17:16 / trr
Benzene	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
Bromobenzene	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
Bromochloromethane	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
Bromodichloromethane	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
Bromomethane	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
Carbon tetrachloride	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
Chlorobenzene	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
Chloroethane	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
2-Chloroethyl vinyl ether	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
Chloroform	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
Chloromethane	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
2-Chlorotoluene	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
4-Chlorotoluene	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
Chlorodibromomethane	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
1,2-Dibromoethane	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
Dibromomethane	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
1,2-Dichlorobenzene	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr

Report RL - Analyte reporting limit.

Definitions: QCL - Quality control limit.

D - RL increased due to sample matrix interference.

MCL - Maximum contaminant level

ND - Not detected at the reporting limit

LABORATORY ANALYTICAL REPORT

Client: MT DEQ
 Project: ASARCO Slag Pile
 Lab ID: H05040130-005
 Client Sample ID: ASP05-C9

Report Date: 05/02/05
 Collection Date: 04/14/05 14:44
 Date Received: 04/14/05
 Matrix: Solid

Analyses	Result	Units	Qual	MCL/		Method	Analysis Date / By
				RL	QCL		
VOLATILE ORGANIC COMPOUNDS							
1,3-Dichlorobenzene	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
1,4-Dichlorobenzene	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
Dichlorodifluoromethane	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
1,1-Dichloroethane	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
1,2-Dichloroethane	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
cis-1,2-Dichloroethene	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
1,1-Dichloroethene	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
trans-1,2-Dichloroethene	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
1,2-Dichloropropane	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
1,3-Dichloropropane	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
2,2-Dichloropropane	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
1,1-Dichloropropene	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
cis-1,3-Dichloropropene	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
trans-1,3-Dichloropropene	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
Ethylbenzene	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
Methyl tert-butyl ether (MTBE)	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
Methylene chloride	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
Methyl ethyl ketone	ND	mg/kg		4.0		SW8260B	04/21/05 17:16 / trr
Styrene	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
1,1,1,2-Tetrachloroethane	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
1,1,2,2-Tetrachloroethane	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
Tetrachloroethene	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
Toluene	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
1,1,1-Trichloroethane	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
1,1,2-Trichloroethane	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
Trichloroethene	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
Trichlorofluoromethane	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
1,2,3-Trichloropropane	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
Vinyl chloride	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
m+p-Xylenes	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
o-Xylene	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
Surr: p-Bromofluorobenzene	118	%REC			78-160	SW8260B	04/21/05 17:16 / trr
Surr: Dibromofluoromethane	104	%REC			70-132	SW8260B	04/21/05 17:16 / trr
Surr: 1,2-Dichloroethane-d4	104	%REC			60-136	SW8260B	04/21/05 17:16 / trr
Surr: Toluene-d8	104	%REC			75-138	SW8260B	04/21/05 17:16 / trr
SEMI-VOLATILE ORGANIC COMPOUNDS							
Acenaphthene	ND	mg/kg		0.33		SW8270C	04/21/05 14:39 / sm
Acenaphthylene	ND	mg/kg		0.33		SW8270C	04/21/05 14:39 / sm
Anthracene	ND	mg/kg		0.33		SW8270C	04/21/05 14:39 / sm
Benzo(a)anthracene	ND	mg/kg		0.33		SW8270C	04/21/05 14:39 / sm

Report RL - Analyte reporting limit.
 Definitions: QCL - Quality control limit.

MCL - Maximum contaminant level
 ND - Not detected at the reporting limit.

Client: MT DEQ
 Project: ASARCO Slag Pile
 Lab ID: H05040130-005
 Client Sample ID: ASP05-C9

Report Date: 05/02/05
 Collection Date: 04/14/05 14:44
 Date Received: 04/14/05
 Matrix: Solid

Analyses	Result	Units	Qual	MCL/		Method	Analysis Date / By
				RL	QCL		
SEMI-VOLATILE ORGANIC COMPOUNDS							
Benzo(a)pyrene	ND	mg/kg		0.33		SW8270C	04/21/05 14:39 / sm
Benzo(b)fluoranthene	ND	mg/kg		0.33		SW8270C	04/21/05 14:39 / sm
Benzo(g,h,i)perylene	ND	mg/kg		0.33		SW8270C	04/21/05 14:39 / sm
Benzo(k)fluoranthene	ND	mg/kg		0.33		SW8270C	04/21/05 14:39 / sm
Chrysene	ND	mg/kg		0.33		SW8270C	04/21/05 14:39 / sm
Dibenzo(a,h)anthracene	ND	mg/kg		0.33		SW8270C	04/21/05 14:39 / sm
Fluoranthene	ND	mg/kg		0.33		SW8270C	04/21/05 14:39 / sm
Fluorene	ND	mg/kg		0.33		SW8270C	04/21/05 14:39 / sm
Indeno(1,2,3-cd)pyrene	ND	mg/kg		0.33		SW8270C	04/21/05 14:39 / sm
Naphthalene	ND	mg/kg		0.33		SW8270C	04/21/05 14:39 / sm
Phenanthrene	ND	mg/kg		0.33		SW8270C	04/21/05 14:39 / sm
Pyrene	ND	mg/kg		0.33		SW8270C	04/21/05 14:39 / sm
Surr: 2-Fluorobiphenyl	88.6	%REC			30-115	SW8270C	04/21/05 14:39 / sm
Surr: Nitrobenzene-d5	86.9	%REC			23-120	SW8270C	04/21/05 14:39 / sm
Surr: Terphenyl-d14	98.9	%REC			16-137	SW8270C	04/21/05 14:39 / sm

POLYCHLORINATED BIPHENYLS (PCB'S)

Aroclor 1016	ND	mg/kg		0.017		SW8082	04/24/05 03:40 / law
Aroclor 1221	ND	mg/kg		0.017		SW8082	04/24/05 03:40 / law
Aroclor 1232	ND	mg/kg		0.017		SW8082	04/24/05 03:40 / law
Aroclor 1242	ND	mg/kg		0.017		SW8082	04/24/05 03:40 / law
Aroclor 1248	ND	mg/kg		0.017		SW8082	04/24/05 03:40 / law
Aroclor 1254	ND	mg/kg		0.017		SW8082	04/24/05 03:40 / law
Aroclor 1260	ND	mg/kg		0.017		SW8082	04/24/05 03:40 / law
Aroclor 1262	ND	mg/kg		0.017		SW8082	04/24/05 03:40 / law
Aroclor 1268	ND	mg/kg		0.017		SW8082	04/24/05 03:40 / law
Surr: Decachlorobiphenyl	140	%REC	S		50-126	SW8082	04/24/05 03:40 / law
Surr: Tetrachloro-m-xylene	108	%REC			42-115	SW8082	04/24/05 03:40 / law

Sample extract received a Sulfuric Acid Clean-up (EPA Method 3655) and a Sulfur Clean-up (EPA Method 3660) prior to analysis.

Report Definitions: RL - Analyte reporting limit.
 QCL - Quality control limit.
 S - Spike recovery outside of advisory limits.

MCL - Maximum contaminant level.
 ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Client: MT DEQ
 Project: ASARCO Slag Pile
 Lab ID: H05040130-006
 Client Sample ID: ASP06-D16

Report Date: 05/02/05
 Collection Date: 04/14/05 14:50
 Date Received: 04/14/05
 Matrix: Solid

Analyses	Result	Units	Qual	MCL/		Method	Analysis Date / By
				RL	QCL		
METALS, TOTAL							
Antimony	42.5	mg/kg		5.0		SW6020	04/27/05 01:51 / rth
Arsenic	130	mg/kg		5.0		SW6020	04/27/05 01:51 / rth
Beryllium	ND	mg/kg		5.0		SW5010B	04/22/05 04:17 / jjw
Cadmium	2.2	mg/kg		1.0		SW6010B	04/20/05 19:46 / jjw
Chromium	68.4	mg/kg		5.0		SW6010B	04/20/05 19:46 / jjw
Cobalt	173	mg/kg		5.0		SW6010B	04/20/05 19:46 / jjw
Iron	305000	mg/kg	D	80		SW6010B	04/22/05 04:17 / jjw
Lead	55.5	mg/kg		5.0		SW6010B	04/20/05 19:46 / jjw
Manganese	11800	mg/kg		5.0		SW6010B	04/22/05 04:17 / jjw
Mercury	ND	mg/kg		1.0		SW7471A	04/25/05 14:06 / KC
Nickel	18.8	mg/kg		5.0		SW6020	04/27/05 01:51 / rth
Phosphorus	647	mg/kg		10		SW6010B	04/22/05 04:17 / jjw
Selenium	11.0	mg/kg		5.0		SW6020	04/27/05 01:51 / rth
Zinc	19100	mg/kg		5.0		SW6010B	04/22/05 04:17 / jjw

Report
 Definitions: RL - Analyte reporting limit.
 QCL - Quality control limit.
 D - RL increased due to sample matrix interference.

MCL - Maximum contaminant level.
 ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Client: MT DEQ
 Project: ASARCO Slag Pile
 Lab ID: H05040130-007
 Client Sample ID: ASP07-F3

Report Date: 05/02/05
 Collection Date: 04/14/05 14:57
 Date Received: 04/14/05
 Matrix: Solid

Analyses	Result	Units	Qual	MCL/		Method	Analysis Date / By
				RL	QCL		
METALS, TOTAL							
Antimony	42.7	mg/kg		5.0		SW6020	04/27/05 01:58 / rih
Arsenic	102	mg/kg		5.0		SW6020	04/27/05 01:58 / rih
Beryllium	ND	mg/kg		5.0		SW6010B	04/22/05 04:20 / jjw
Cadmium	1.9	mg/kg		1.0		SW6010B	04/20/05 19:49 / jjw
Chromium	70.5	mg/kg		5.0		SW6010B	04/20/05 19:49 / jjw
Cobalt	171	mg/kg		5.0		SW6010B	04/20/05 19:49 / jjw
Iron	286000	mg/kg	D	80		SW6010B	04/22/05 04:20 / jjw
Lead	45.3	mg/kg		5.0		SW6010B	04/20/05 19:49 / jjw
Manganese	12100	mg/kg		5.0		SW6010B	04/22/05 04:20 / jjw
Mercury	ND	mg/kg		1.0		SW7471A	04/25/05 14:10 / KC
Nickel	17.4	mg/kg		5.0		SW6020	04/27/05 01:58 / rih
Phosphorus	578	mg/kg		10		SW6010B	04/22/05 04:20 / jjw
Selenium	13.8	mg/kg		5.0		SW6020	04/27/05 01:58 / rih
Zinc	19100	mg/kg		5.0		SW6010B	04/22/05 04:20 / jjw

Report RL - Analyte reporting limit.

Definitions: QCL - Quality control limit.

D - RL increased due to sample matrix interference.

MCL - Maximum contaminant level.

ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Client: MT DEQ
Project: ASARCO Slag Pile
Lab ID: H05040130-008
Client Sample ID: ASP08-G2

Report Date: 05/02/05
Collection Date: 04/14/05 15:04
Date Received: 04/14/05
Matrix: Solid

Analyses	Result	Units	Qual	MCL		Method	Analysis Date / By
				RL	QCL		
PHYSICAL CHARACTERISTICS							
Moisture	0.800	wt%		0.0100		SW3550A	04/22/05 08:15 / MC
CHEMICAL CHARACTERISTICS							
pH, 1:2	9.2	s.u.		0.1		ASA10-3	04/25/05 16:18 / srm
Chloride, 1:2	1.06	mg/kg		1.00		ASA10-3	04/26/05 12:48 / qed
METALS, TOTAL							
Antimony	43.8	mg/kg		5.0		SW6020	04/27/05 02:05 / rth
Arsenic	119	mg/kg		5.0		SW6020	04/27/05 02:05 / rth
Beryllium	ND	mg/kg		5.0		SW6010B	04/22/05 04:24 / jjw
Cadmium	2.5	mg/kg		1.0		SW6010B	04/20/05 20:00 / jjw
Chromium	59.8	mg/kg		5.0		SW6010B	04/20/05 20:00 / jjw
Cobalt	194	mg/kg		5.0		SW6010B	04/20/05 20:00 / jjw
Iron	290000	mg/kg	D	80		SW6010B	04/22/05 04:24 / jjw
Lead	118	mg/kg		5.0		SW6010B	04/20/05 20:00 / jjw
Manganese	13100	mg/kg		5.0		SW6010B	04/22/05 04:24 / jjw
Mercury	ND	mg/kg		1.0		SW7471A	04/25/05 14:12 / KC
Nickel	17.9	mg/kg		5.0		SW6020	04/27/05 02:05 / rth
Phosphorus	720	mg/kg		10		SW6010B	04/22/05 04:24 / jjw
Selenium	9.9	mg/kg		5.0		SW6020	04/27/05 02:05 / rth
Zinc	21100	mg/kg		5.0		SW6010B	04/22/05 04:24 / jjw
VOLATILE ORGANIC COMPOUNDS							
Bromoform	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
Benzene	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
Bromobenzene	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
Bromochloromethane	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
Bromodichloromethane	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
Bromomethane	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
Carbon tetrachloride	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
Chlorobenzene	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
Chloroethane	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
2-Chloroethyl vinyl ether	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
Chloroform	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
Chloromethane	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
2-Chlorotoluene	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
4-Chlorotoluene	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
Chlorodibromomethane	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
1,2-Dibromoethane	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
Dibromomethane	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
1,2-Dichlorobenzene	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr

Report RL - Analyte reporting limit.

Definitions: QCL - Quality control limit.

D - RL increased due to sample matrix interference.

MCL - Maximum contaminant level.

ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Client: MT DEQ
 Project: ASARCO Slag Pile
 Lab ID: H05040130-008
 Client Sample ID: ASP08-G2

Report Date: 05/02/05
 Collection Date: 04/14/05 15:04
 Date Received: 04/14/05
 Matrix: Solid

Analyses	Result	Units	Qual	MCL/		Method	Analysis Date / By
				RL	QCL		
VOLATILE ORGANIC COMPOUNDS							
1,3-Dichlorobenzene	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
1,4-Dichlorobenzene	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
Dichlorodifluoromethane	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
1,1-Dichloroethane	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
1,2-Dichloroethane	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
cis-1,2-Dichloroethene	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
1,1-Dichloroethene	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
trans-1,2-Dichloroethene	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
1,2-Dichloropropane	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
1,3-Dichloropropane	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
2,2-Dichloropropane	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
1,1-Dichloropropene	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
cis-1,3-Dichloropropene	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
trans-1,3-Dichloropropene	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
Ethylbenzene	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
Methyl tert-butyl ether (MTBE)	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
Methylene chloride	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
Methyl ethyl ketone	ND	mg/kg		4.0		SW8260B	04/21/05 17:51 / trr
Styrene	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
1,1,1,2-Tetrachloroethane	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
1,1,1,2,2-Tetrachloroethane	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
Tetrachloroethene	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
Toluene	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
1,1,1-Trichloroethane	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
1,1,2-Trichloroethane	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
Trichloroethene	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
Trichlorofluoromethane	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
1,2,3-Trichloropropane	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
Vinyl chloride	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
m+p-Xylenes	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
o-Xylene	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
Surr: p-Bromofluorobenzene	112	%REC			78-160	SW8260B	04/21/05 17:51 / trr
Surr: Dibromofluoromethane	103	%REC			70-132	SW8260B	04/21/05 17:51 / trr
Surr: 1,2-Dichloroethane-d4	102	%REC			60-136	SW8260B	04/21/05 17:51 / trr
Surr: Toluene-d8	102	%REC			75-138	SW8260B	04/21/05 17:51 / trr
SEMI-VOLATILE ORGANIC COMPOUNDS							
Acenaphthene	ND	mg/kg		0.33		SW8270C	04/21/05 15:21 / sm
Acenaphthylene	ND	mg/kg		0.33		SW8270C	04/21/05 15:21 / sm
Anthracene	ND	mg/kg		0.33		SW8270C	04/21/05 15:21 / sm
Benzo[a]anthracene	ND	mg/kg		0.33		SW8270C	04/21/05 15:21 / sm

Report RL - Analyte reporting limit.
 Definitions: QCL - Quality control limit.

MCL - Maximum contaminant level.
 ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Client: MT DEQ
 Project: ASARCO Slag Pile
 Lab ID: H05040130-008
 Client Sample ID: ASP08-G2

Report Date: 05/02/05
 Collection Date: 04/14/05 15:04
 Date Received: 04/14/05
 Matrix: Solid

Analyses	Result	Units	Qual	MCL/		Method	Analysis Date / By
				RL	QCL		
SEMI-VOLATILE ORGANIC COMPOUNDS							
Benzo(a)pyrene	ND	mg/kg		0.33		SW8270C	04/21/05 15:21 / sm
Benzo(b)fluoranthene	ND	mg/kg		0.33		SW8270C	04/21/05 15:21 / sm
Benzo(g,h,i)perylene	ND	mg/kg		0.33		SW8270C	04/21/05 15:21 / sm
Benzo(k)fluoranthene	ND	mg/kg		0.33		SW8270C	04/21/05 15:21 / sm
Chrysene	ND	mg/kg		0.33		SW8270C	04/21/05 15:21 / sm
Dibenzo(a,h)anthracene	ND	mg/kg		0.33		SW8270C	04/21/05 15:21 / sm
Fluoranthene	ND	mg/kg		0.33		SW8270C	04/21/05 15:21 / sm
Fluorene	ND	mg/kg		0.33		SW8270C	04/21/05 15:21 / sm
Indeno(1,2,3-cd)pyrene	ND	mg/kg		0.33		SW8270C	04/21/05 15:21 / sm
Naphthalene	ND	mg/kg		0.33		SW8270C	04/21/05 15:21 / sm
Phenanthrene	ND	mg/kg		0.33		SW8270C	04/21/05 15:21 / sm
Pyrene	ND	mg/kg		0.33		SW8270C	04/21/05 15:21 / sm
Surr: 2-Fluorobiphenyl	75.9	%REC			30-115	SW8270C	04/21/05 15:21 / sm
Surr: Nitrobenzene-d5	76.0	%REC			23-120	SW8270C	04/21/05 15:21 / sm
Surr: Terphenyl-d14	88.9	%REC			18-137	SW8270C	04/21/05 15:21 / sm
POLYCHLORINATED BIPHENYLS (PCB'S)							
Aroclor 1016	ND	mg/kg		0.017		SW8082	04/24/05 04:08 / law
Aroclor 1221	ND	mg/kg		0.017		SW8082	04/24/05 04:08 / law
Aroclor 1232	ND	mg/kg		0.017		SW8082	04/24/05 04:08 / law
Aroclor 1242	ND	mg/kg		0.017		SW8082	04/24/05 04:08 / law
Aroclor 1248	ND	mg/kg		0.017		SW8082	04/24/05 04:08 / law
Aroclor 1254	ND	mg/kg		0.017		SW8082	04/24/05 04:08 / law
Aroclor 1250	ND	mg/kg		0.017		SW8082	04/24/05 04:08 / law
Aroclor 1262	ND	mg/kg		0.017		SW8082	04/24/05 04:08 / law
Aroclor 1268	ND	mg/kg		0.017		SW8082	04/24/05 04:08 / law
Surr: Decachlorobiphenyl	125	%REC			50-126	SW8082	04/24/05 04:08 / law
Surr: Tetrachloro-m-xylene	90.0	%REC			42-115	SW8082	04/24/05 04:08 / law

Sample extract received a Sulfuric Acid Clean-up (EPA Method 3655) and a Sulfur Clean-up (EPA Method 3650) prior to analysis.

Report Definitions: RL - Analyte reporting limit.
 QCL - Quality control limit.

MCL - Maximum contaminant level.
 ND - Not detected at the reporting limit.

Client: MT DEQ
 Project: ASARCO Slag Pile
 Lab ID: H05040130-009
 Client Sample ID: ASP09-G4

Report Date: 05/02/05
 Collection Date: 04/14/05 15:07
 Date Received: 04/14/05
 Matrix: Solid

Analyses	Result	Units	Qual	MCL/		Method	Analysis Date / By
				RL	QCL		
METALS, TOTAL							
Antimony	57.6	mg/kg		5.0		SW6020	04/27/05 02:12 / rih
Arsenic	109	mg/kg		5.0		SW6020	04/27/05 02:12 / rih
Beryllium	ND	mg/kg		5.0		SW6010B	04/22/05 04:27 / jjw
Cadmium	1.4	mg/kg		1.0		SW6010B	04/20/05 20:04 / jjw
Chromium	90.0	mg/kg		5.0		SW6010B	04/20/05 20:04 / jjw
Cobalt	204	mg/kg		5.0		SW6010B	04/20/05 20:04 / jjw
Iron	294000	mg/kg	D	80		SW6010B	04/22/05 04:27 / jjw
Lead	64.0	mg/kg		5.0		SW6010B	04/20/05 20:04 / jjw
Manganese	11900	mg/kg		5.0		SW6010B	04/22/05 04:27 / jjw
Mercury	ND	mg/kg		1.0		SW7471A	04/25/05 14:14 / KC
Nickel	20.6	mg/kg		5.0		SW6020	04/27/05 02:12 / rih
Phosphorus	562	mg/kg		10		SW6010B	04/22/05 04:27 / jjw
Selenium	12.2	mg/kg		5.0		SW6020	04/27/05 02:12 / rih
Zinc	20100	mg/kg		5.0		SW6010B	04/22/05 04:27 / jjw

Report Definitions: RL - Analyte reporting limit.
 OCL - Quality control limit.
 D - RL increased due to sample matrix interference.

MCL - Maximum contaminant level.
 ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Client: MT DEQ
 Project: ASARCO Slag Pile
 Lab ID: H05040130-010
 Client Sample ID: ASP10-H16

Report Date: 05/02/05
 Collection Date: 04/14/05 15:15
 Date Received: 04/14/05
 Matrix: Solid

Analyses	Result	Units	Qual	MCL/		Method	Analysis Date / By
				RL	QCL		
METALS, TOTAL							
Antimony	34.1	mg/kg		5.0		SW6020	04/22/05 05:23 / rth
Arsenic	117	mg/kg		5.0		SW6020	04/22/05 05:23 / rth
Beryllium	ND	mg/kg		5.0		SW6010B	04/22/05 04:31 / jjw
Cadmium	2.1	mg/kg		1.0		SW6010B	04/20/05 20:07 / jjw
Chromium	59.0	mg/kg		5.0		SW6010B	04/20/05 20:07 / jjw
Cobalt	137	mg/kg		5.0		SW6010B	04/20/05 20:07 / jjw
Iron	305000	mg/kg	D	80		SW6010B	04/22/05 04:31 / jjw
Lead	103	mg/kg		5.0		SW6010B	04/20/05 20:07 / jjw
Manganese	10400	mg/kg		5.0		SW6010B	04/22/05 04:31 / jjw
Mercury	ND	mg/kg		1.0		SW7471A	04/25/05 14:16 / KC
Nickel	14.7	mg/kg		5.0		SW6020	04/22/05 05:23 / rth
Phosphorus	710	mg/kg		10		SW6010B	04/22/05 04:31 / jjw
Selenium	9.1	mg/kg		5.0		SW6020	04/22/05 05:23 / rth
Zinc	22200	mg/kg		5.0		SW6010B	04/22/05 04:31 / jjw

Report RL - Analyte reporting limit.

Definitions: QCL - Quality control limit.

D - RL increased due to sample matrix interference.

MCL - Maximum contaminant level.

ND - Not detected at the reporting limit.

APPENDIX 4-1-2

SUMMARY OF SLAG TESTING ANALYSES INCLUDING TEST BASIN WATER QUALITY, SLAG BOTTLE ROLL TESTS AND EP TOXICITY TESTS

OF 2012 WATER QUALITY ANALYSES - ASARCO EAST HELENA

SITE NAME	FUMED SLAG	FUMED SLAG	FUMED SLAG	FUMED SLAG	FUMED SLAG	FUMED SLAG	FUMED SLAG	FUMED SLAG	FUMED SLAG	FUMED SLAG
SAMPLE DATE	12/30/86	04/02/87	04/22/87	04/22/87	05/22/87	05/22/87	05/22/87	05/22/87	05/22/87	07/15/87
LAP	ASARCO	ASARCO	ASARCO	CHMTC	ASARCO	ASARCO	CHMTC	CHMTC	CHMTC	ASARCO
REMARKS	KOTILE			SPLIT	REPLICATE		SPLIT	REPLICATE	REPLICATE	
SAMPLE NUMBER		8704-1	8704-20		8705-50	8705-47			8707-02	8707-01
PHYSICAL PARAMETERS										
WATER TEMPERATURE (C)			7.5			9.7				
SPEC. COND. (UMHOS/CM) FIELD			2235		2268	2265			2137	2150
SPEC. COND. (UMHOS/CM) LAB	115	1950	2250			2320				2400
PH FIELD			6.16		7.48	7.69				7.46
PH LAB	9.9	7.77	6.81			7.52				7.55
TDS MEAS. @ 180 DEG. C	94	1842	1903	993		2086	2227			1912
OXYGEN (O) DISS			4.3			4.3				4.1
DEPTH TO SWL BELOW MP (FT)			8.74			8.01				
COMMON IONS										
CALCIUM (CA)	12	510	454	449.0		422	417.0	412.0		321
MAGNESIUM (MG)	0.49	20	25.5	27.40		20.2	25.10	24.90		22.9
SODIUM (NA)	5.1	76	71.5	76.6		85	72.5	71.8		74
POTASSIUM (K)	3.9	54	65	60.80		74	136.00	122.00		68
BICARBONATE (HCO3) (LAB)	11.0	260	102			98				84
CARBONATE AS CO3 (LAB)	19	11	11			11				11.0
SULFATE (SO4)	10	1450	1425	1240.0		1338	1304.0			1200
CHLORIDE (CL)	18	6.0	7.0	10.0		7.0	30.0			4.0
TRACE ELEMENTS										
ARSENIC (AS) DISS	0.19	0.0325	0.0283	0.0198	0.038	0.030	0.0530	0.0320	0.057	0.039
ARSENIC (AS) +3			0.014						0.0216	0.040
ARSENIC (AS) +5			0.010						0.0722	0.0268
CADMIUM (CD) DISS	0.003	0.075	0.060	0.0720	0.051	0.051	0.0520	0.0500	0.055	0.049
COFFER (CU) DISS	0.008	0.280	0.193	0.2260	0.125	0.128	0.1480	0.1340	0.118	0.110
IRON (FE) DISS	0.11	0.020	0.020	0.100	0.044	0.045	0.100	0.100	0.020	0.020
IRON (FE II)			0.010						0.060	0.080
LEAD (PB) DISS	0.017	0.045	0.030	0.0334	0.019	0.020	0.0323	0.0432	0.016	0.021
MANGANESE (MN) DISS	0.017	1.060	1.440	2.640	1.910	1.930	2.660	2.640	2.930	2.890
ZINC (ZN) DISS	0.023	3.580	3.700	4.450	2.830	2.890	2.860	2.820	2.500	2.300

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested.

Output Date: 03-19-1989
HWQ-6/86-R1

SLAG WATER QUALITY ANALYSES - ASARCO EAST HELENA

SITE NAME	FUMED SLAG	FUMED SLAG	UNFUMED SLAG	UNFUMED SLAG	UNFUMED SLAG	UNFUMED SLAG	UNFUMED SLAG	UNFUMED SLAG	UNFUMED SLAG
SAMPLE DATE	02/22/87	02/22/87	12/30/84	04/22/87	04/22/87	05/22/87	05/22/87	07/15/87	09/22/87
LAB	ASARCO	ASARCO	ASARCO	ASARCO	CHMTC	CHMTC	ASARCO	ASARCO	ASARCO
REMARKS	REPLICATE		BOTTLE		SPLIT	SPLIT			
SAMPLE NUMBER	8709-06	8709-04	ROLL TEST	8704-24			8705-48	8707-03	8709-07
PHYSICAL PARAMETERS									
WATER TEMPERATURE (C)		16 *		10.5			10.9		17 *
SPEC. COND. (UMHOS/CM) FIELD	1368	1366		16296 *			19978	19850	
SPEC. COND. (UMHOS/CM) LAB		1350	200	16500			20200	22000	12200
PH FIELD				9.49			9.97 *	9.48	
PH LAB		7.63	10.4	9.25			9.6	9.73	9.69
TDS MEAS. @ 180 DEG. C		1114	206	14183 *	7298	18720	18523	18172 *	10984
OXYGEN (O) DISS		4.0		4.5			3.2	3.0	4.1
DEPTH TO SUL BELOW MP (FT)		7.74		8.83			7.85		7.02
COMMON IONS									
CALCIUM (CA)		126.5	17	371	437.0		361	424	345
MAGNESIUM (MG)		11	0.22	8.5	8.76		6.7	6.4	4.2
SODIUM (NA)		45	19	2900	2960.0		3890	3800	2200
POTASSIUM (K)		65	22	1950	158.00		2650	2550	1540
ALKALINITY AS CaCO3 (LAB)							587		
BICARBONATE (HCO3) (LAB)		72	(1.0	486 *			(1	(1.0	(1.0
CARBONATE AS CO3 (LAB)		(1.0	36	(1			284	163	197
HYDROXIDE (OH)							38	46	30
SULFATE (SO4)		480 *	16	9200	2480.0	2463.0	1200	11750	6750
CHLORIDE (CL)		3.0	16	57	63.0	75.0	66	74	35
TRACE ELEMENTS									
ARSENIC (AS) DISS	0.075 *	0.054 *	0.31	0.620	0.5130		0.353	0.590 *	0.553
ARSENIC (AS) +3				0.400				0.550	
ARSENIC (AS) +5				0.030				0.054	
CADMIUM (CD) DISS	0.021	0.021	0.003	0.030 *	0.0063		0.003	0.005	0.003
COFFER (CU) DISS	0.055	0.056	0.008	0.130	0.1190		0.128	0.085	0.043
IRON (FE) DISS	(0.020	(0.020	0.070	0.150	(0.100		0.225 *	(0.020	(0.020
IRON (FE II)	0.02	(0.01		(0.010				0.070	(0.01
LEAD (PB) DISS	0.023	0.026	0.083	0.098 *	0.1430		0.0505	0.021 *	0.094
MANGANESE (MN) DISS	1.590	1.540	(0.017	0.155 *	0.139		0.083	0.090	0.050
ZINC (ZN) DISS	0.813	0.788 *	0.053	0.100 *	0.090		0.048	0.030	0.023

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested.

Output Date: 03-19-1989
HWQ-6/86-F1

TABLE 1
East Helena

SLAG SAMPLE LEACHATE ANALYSIS

1979

979

SARCO

Lab No.

Lab No.	Description	(PPM in Leachate)								
		As	Ba	Cd	Cr	Pb	Hg	Se	Ag	(Zn)
3278	Slag 1 (2)	.018	.3	.08	<.01	.6	<.001	<.005	<.01	3.5
3279	Slag 2 (2)	<.014	.1	.13	<.01	<.1	<.001	<.005	<.01	2.6
3280	Slag 3 (2)	.020	.1	.03	<.01	3.4	<.001	<.005	<.01	2.1
3281	Slag 4 (2)	<.014	.2	<.01	<.01	<.1	<.001	<.005	<.01	1.0
3282	Slag 5 (2)	.032	.2	<.01	<.01	3.3	<.001	<.005	<.01	5.0
3283	Slag 6 (2)	<.014	.1	.15	<.01	1.0	<.001	<.005	<.01	6.0

Maximum Contaminant
Levels for Non-
toxic Leachates

(0.5)	10.0	0.1	0.5	0.5	.02	0.1	0.5	---	*
-------	------	-----	-----	-----	-----	-----	-----	-----	---

NOTE →

Currently unspecified but estimated to be 50 ppm (10 times the Drinking Water Standard).

15

ASARCO Incorporated
Department of Environmental Sciences
EAST HELENA
Miscellaneous Sample Results

ASARCO LAB #	SAMPLE DESCRIPTION	1985 SAMPLE DATE	As ppm	Cd ppm	Pb ppm
3658 Air Cooled	Blast Furnace Slag	5/ 7	.12	.002	5.3
3659 Granulated	Blast Furnace Slag	5/ 7	.047	<.002	.050

ASARCO Incorporated
Department of Environmental Sciences
EAST HELENA
Miscellaneous Sample Results

ASARCO LAB #	SAMPLE DESCRIPTION	1985 SAMPLE DATE	Ag ppm	As ppm	Ba ppm	Cd ppm	Cl ppm
7860	TCLP-Fumed Blast Furnace Slag	10/21	<.002	.45	4.6	.007	.
7861	TCLP-Unfumed Blast Furnace Slag	10/21	<.002	1.2	1.6	.25	.

ASARCO LAB #	SAMPLE DESCRIPTION	1985 SAMPLE DATE	Hg ppb	Pb ppm	Se ppm
7860	TCLP-Fumed Blast Furnace Slag	10/21	<.005	.28	.004
7861	TCLP-Unfumed Blast Furnace Slag	10/21	<.001	10.	.010

ASARCO Incorporated
Department of Environmental Sciences
EAST HELENA
Miscellaneous Sample Results

ASARCO LAB #	SAMPLE DESCRIPTION	1985 SAMPLE DATE	Ag ppm	As ppm	Ba ppm	Cd ppm	p
6378	Air Cooled Slag	8/15	<.005	.012	<1.0	.002	
6379	Granulated Slag	8/15	<.005	.010	<1.0	<.002	

ASARCO LAB #	SAMPLE DESCRIPTION	1985 SAMPLE DATE	Hg ppb	Pb ppm	Se ppm	pH
6378	Air Cooled Slag	8/15	<.50	1.1	<.080	9.2
6379	Granulated Slag	8/15	<.50	.050	<.080	8.0

ASARCO Incorporated
Department of Environmental Sciences
EAST HELENA
Miscellaneous Sample Results

ASARCO LAB #	SAMPLE DESCRIPTION	1983 SAMPLE DATE	Pb ppm	Cd ppm	Cr ppm	Ag ppm	Ba ppm
11370	2-4 mo. old Slag Composite	11/28	9.8	3.9	<.030	<.008	7.2
11371	1 week old Slag Composite	11/28	3.9	<.004	<.030	<.008	8.7

ASARCO LAB #	SAMPLE DESCRIPTION	1983 SAMPLE DATE	As ppm	Se ppm	Hg ppb	pH
11370	2-4 mo. old Slag Composite	11/28	.20	.012	<.50	10.
11371	1 week old Slag Composite	11/28	.35	<.004	<.50	10.

	ppm							
	<u>Ba</u>	<u>Pb</u>	<u>Cd</u>	<u>Cr</u>	<u>Ag</u>	<u>Se</u>	<u>Hg</u>	<u>As</u>
Maximum allowable levels of contaminants in the leachate of a non-toxic material.....	100.	5.0	1.0	5.0	5.0	1.0	.2	5.0

storage area. The sediments are being stored in a protected environment to prevent contamination of the adjacent area from dispersion of the sediments by wind and water. The sediments are located on a concrete pad to prevent contact with adjacent soils. A containment berm around the perimeter of the sediment pile diverts run-on. A geomembrane cover over the sediments prevents wind and water dispersion and eliminates subsequent generation of leachate.

Approximately 31,000 cubic yards of dewatered sediments were transported to the Lower Ore Storage Area. Four thousand cubic yards of these sediments were smelted prior to the stockpile being covered with a geomembrane liner in October 1997. The sediments will remain in this interim storage facility while EPA considers Asarco's request to modify the sediment smelting requirement of the ROD, and instead dispose of these materials in the on-site CAMU.

4.1.4 Slag

The effect of the slag pile on groundwater and surface water was evaluated as part of the 1990 Comprehensive RI/FS. The evaluation was conducted in accordance with procedures presented in the Comprehensive RI/FS Work Plan (Hydrometrics 1987). Based on the results of the evaluation, the RI/FS concluded that the potential for impacts to groundwater and surface water from slag is low and the subsequent ROD did not specify any remedial action for the Slag Pile Operable Unit. Post-RI/FS monitoring at adjacent surface water and groundwater monitoring sites is on-going. A summary of the slag investigation and the findings of the RI relative to slag are presented below.

4.1.4.1 Investigation of Potential Groundwater Impacts

Slag Infiltration Test Basin Construction, Water Level Measurement, Water Quality Sampling and Analysis

Infiltration and percolation of precipitation into the slag pile were directly measured in slag test basins constructed in fumed and unfumed slag. Fumed slag is a by-product of the zinc

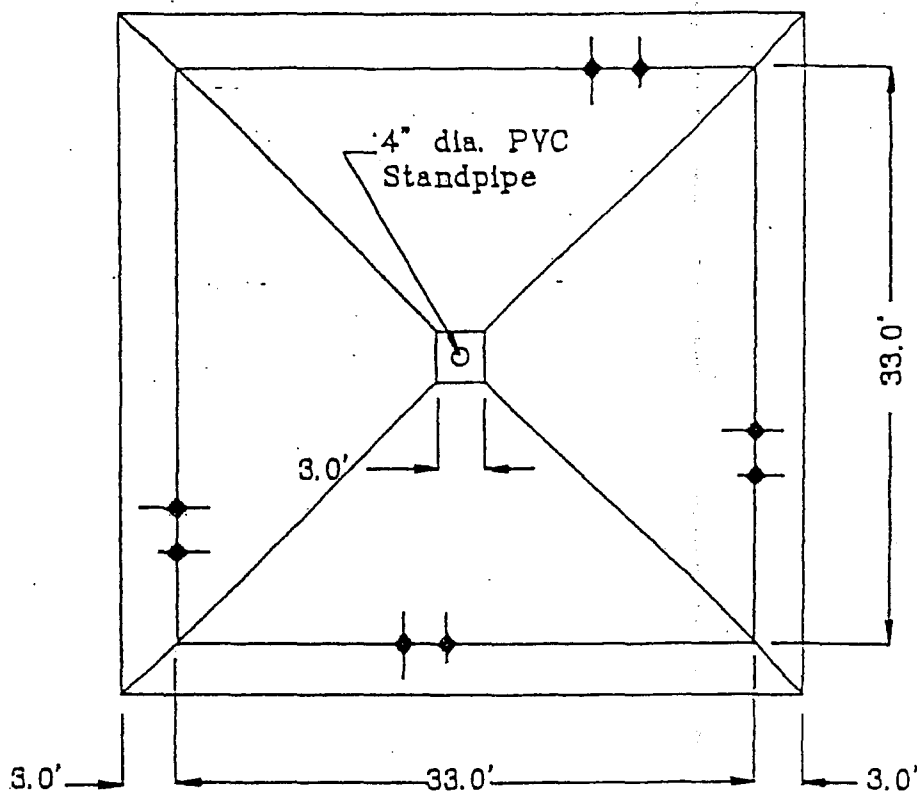
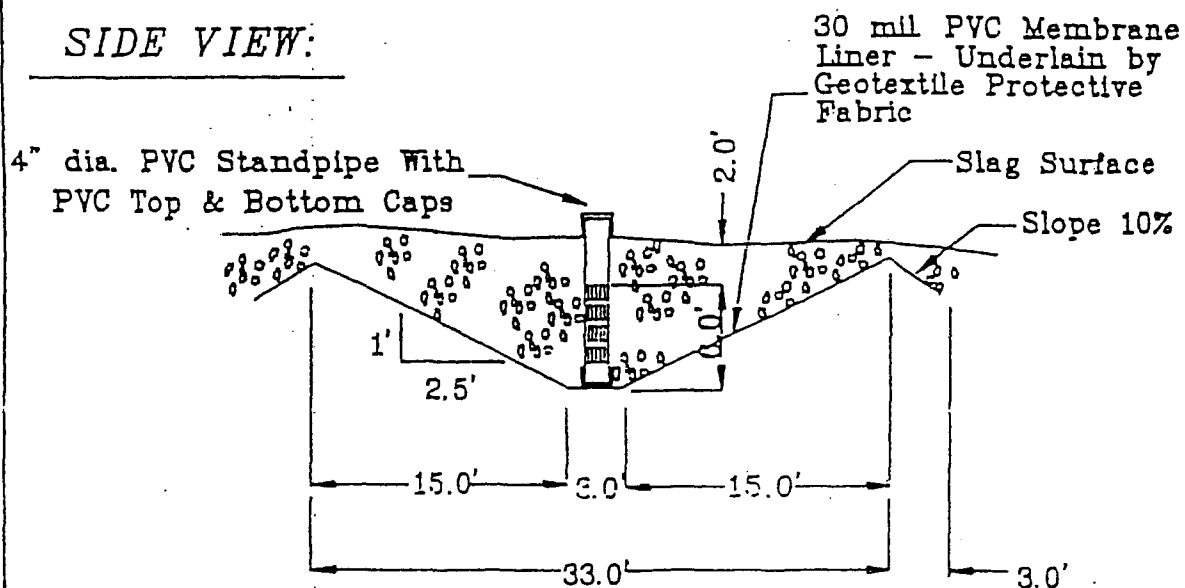
recovery process, which consisted of air injection into molten slag to recover zinc oxide. Unfumed slag is a by-product of the blast furnace which has not been further processed through the zinc recovery process. The zinc recovery process was suspended in 1982 and zinc is no longer recovered from the slag. Since 1982, unfumed slag has been placed in an area segregated from fumed slag.

Two slag infiltration catchment basins were constructed; one in a typical location in the fumed slag, and one in a typical location in unfumed slag. Construction of the test basins included removal of a 2 to 3 meter layer of slag, placement of an impervious 36-mil reinforced Hypalon liner in the excavation, installation of a collection sump, and replacement of the slag. Figure 4-1-8 shows the slag test basin design.

Water elevations in the collection sumps were measured periodically, and after rainfall or snowmelt events to determine the actual accumulation of water in the slag basins. Collected water was pumped from the sump, sent to the TSC laboratory, and tested for the parameters listed in Table 3-2-2. Analytical results of water collected in the test basins are summarized in Appendix 4-1-2.

Slag Material Sampling and Analysis

To supplement slag information collected from the test basins, samples of slag were collected from the test basin sites and sent to the TSC lab for "bottle roll" tests. Estimates of slag leachability were obtained by conducting "bottle roll" test on slag samples. Bottle roll tests involved placing samples of slag in bottles in the laboratory, adding deionized water, agitating the bottles for approximately 24 hours, then analyzing the water for concentrations of arsenic and metals. Details of the bottle roll extraction tests are in the Quality Assurance Project Plan (QAPP) Addendum to the Phase II Water Resources Investigation Work Plan (Hydrometrics, 1986). Bottle roll test results are in Appendix 4-1-2.

PLAN VIEW:SIDE VIEW:

NOTE: PVC Standpipe is schedule 40, capped on both ends and perforated with saw-cut slots from 2.0' to 8.0' beneath the slag surface.

In addition to the slag sampling and bottle roll test performed as part of the East Helena RI activities, additional slag samples were collected and analyzed using the EP toxicity procedure. Results of these analyses are also in Appendix 4-1-2.

Assessment of Groundwater Impacts

In an effort to estimate infiltration rates, the volume of water retained in the slag test basins was calculated for 13 time intervals, beginning December 23, 1986 and ending February 10, 1988. These volumes were compared to the volumes of precipitation during the same periods and converted to percentages, as summarized in Table 4-1-10. The percentage of precipitation retained in the basins varied from -6.7% to 61.9% in the fumed slag, and -45% to 61.8% in the unfumed slag (negative percentages indicate evaporation rates exceed precipitation collected in the test basins). Although there is a relationship of test basin water level fluctuations to precipitation (see Figures 4-1-9 and 4-1-10), the relationship may be complicated by variable evaporation, hence, infiltration rates are variable.

Concentrations of arsenic and metals from test basin water samples (see Appendix 4-1-2) were low compared to plant area groundwater. Dissolved arsenic varied from 0.0198 mg/l to 0.075 mg/l in the fumed slag, and 0.353 to 0.590 mg/l in the unfumed slag during the study period. Dissolved cadmium varied from 0.003 to 0.075 mg/l in the fumed slag, and 0.003 to 0.0063 mg/l in the unfumed slag. Dissolved lead varied from 0.016 to 0.045 mg/l in the fumed slag, and 0.021 to 0.098 mg/l in the unfumed slag.

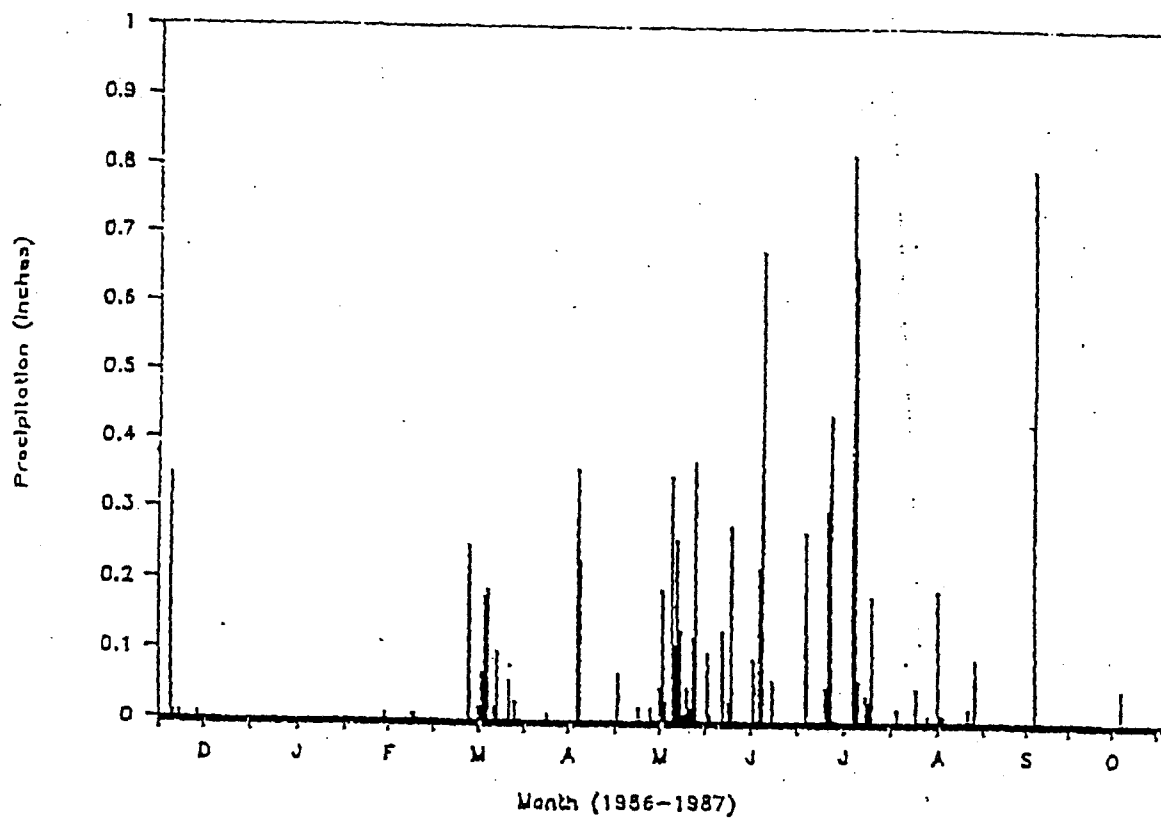
The concentrations of arsenic and metals from bottle roll testing (See Appendix 4-1-2) were similar to the slag test basin water quality. For the fumed slag, dissolved arsenic was 0.19 mg/l, cadmium was 0.003 mg/l, and lead was less than 0.017 mg/l. For the unfumed slag, dissolved arsenic was 0.31 mg/l, cadmium was 0.003 mg/l and lead was 0.083 mg/l.

EP toxicity tests (see Appendix 4-1-2) indicate that leachable trace element concentrations from the slag are variable. From 18 tests, the results for arsenic varied from below detection level to 1.2 ppm with an average of 0.16 ppm; cadmium varied from below detection level to

TABLE 4-1-10. PRECIPITATION COLLECTED IN SLAG TEST BASINS

FUMED SLAG			
Date	Precipitation (inches)	Precipitation Retained *	Percent of Precipitation Retained
12/23/86			
1/22/86	0		
2/23/87	0		
3/26/87	0.75	0.01	1.4
4/21/87	0.23	-0.01	-5.8
5/18/87	0.51	0.32	61.9
6/18/87	2.46	0.49	19.8
7/14/87	0.88	0.25	28.7
8/11/87	1.70	0.36	21.2
9/11/87	0.37	not calculated	
10/14/87	0.65	0.25	38.4
12/7/87	0.45	-0.02	-3.9
1/20/88	0.34	-0.02	-6.7
2/10/88	0.49	-0.01	-1.1
UNFUMED SLAG			
12/23/86			
1/22/87	0		
2/23/87	0		
3/26/87	0.75	0	
4/21/87	0.23	0.12	52.7
5/18/87	0.51	0.27	53.6
6/18/87	2.46	0.73	29.8
7/14/87	0.88	0.28	31.7
8/11/87	1.70	0.12	7.2
9/11/87	0.37	not calculated	
10/14/87	0.65	0.40	61.8
12/7/87	0.45	-0.05	-12.1
1/20/88	0.34	-0.15	-45.0
2/10/88	0.49	0.14	27.6

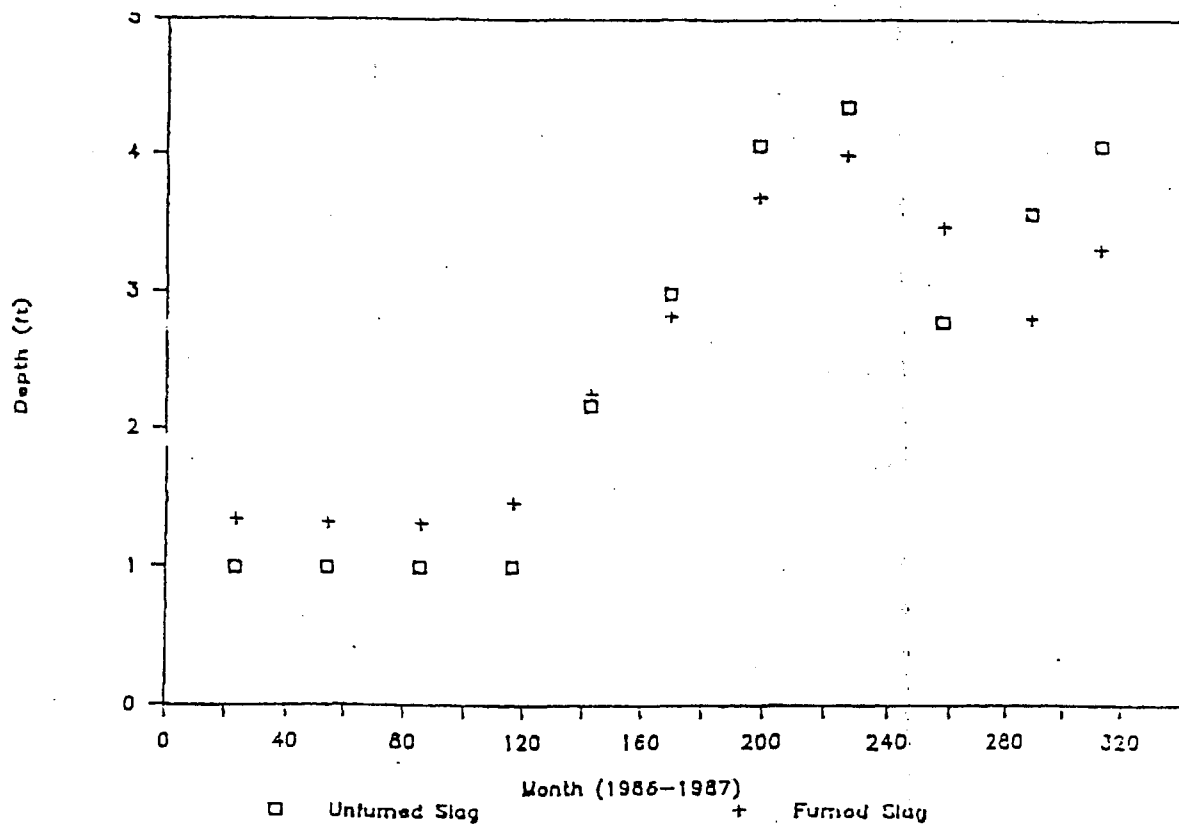
* Value is calculated based on measured water level changes and test basin geometry (Frustum of a general pyramid). Negative values indicate evaporation exceeds infiltration.



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FACILITY

DAILY PRECIPITATION
AT HELENA AIRPORT

FIGURE
4-1-9



CC/RA REPORT
ASARCO EAST HELENA
FACILITY

DEPTH OF WATER IN
SLAG TEST BASIN

FIGURE

4-1-10

3.9 ppm, with an average of 0.26 ppm (only one cadmium value was greater than 0.25 ppm; if the 3.9 ppm value is dropped, the cadmium average concentration is 0.04 ppm); lead values varied from below detection level to 30 ppm, with an average of 5.2 ppm.

The EP Toxicity tests were not conducted as part of the Comprehensive RI/FS activities, but have been included as supplementary data. The EP Toxicity results tend to overpredict the mobility of metals compared to the other test results and observed site conditions due to the low pH of the extractant. In particular, the values for lead appear to be much higher with TCLP than with natural conditions.

Concentrations of arsenic and other metals in the groundwater system are discussed in detail in Section 4.4. In general, results of water quality from the slag basins and bottle roll analyses of slag indicate arsenic concentrations are significantly lower than concentrations observed in monitoring wells both upgradient and downgradient of the slag pile. Figures 4-1-11, 4-1-12, 4-1-13 and 4-1-14 show a comparison to slag test basin water quality, bottle roll test water quality, EP Tox test results, and groundwater quality upgradient and down gradient of the slag pile.

Based on observed recharge rates in the slag test basins and associated water quality data, the slag pile would account for only 1 to 3 percent of the observed arsenic at downgradient monitoring well DH-10 (see Figure 4-1-15). Concentrations of arsenic in these wells are similar to arsenic concentrations in DH-4 near Lower Lake, the apparent source of elevated arsenic in these wells. Based on the results of test basin water quality analyses and bottle roll tests, it is unlikely that slag significantly effects observed arsenic concentration trends on the site.

While EP-Toxicity results indicate that there is some potential for mobility of cadmium, lead and zinc from slag, the results of the test basins and bottle roll tests indicate metals concentrations released from slag is low. In addition, concentrations of cadmium, lead and

FIGURE 4-1-12. CADMIUM CONCENTRATION DATA FROM GROUNDWATER MONITORING WELLS IN THE SLAG PILE AREA, AND FROM SLAG TEST BASIN AND SLAG LEACHABILITY TESTING RESULTS

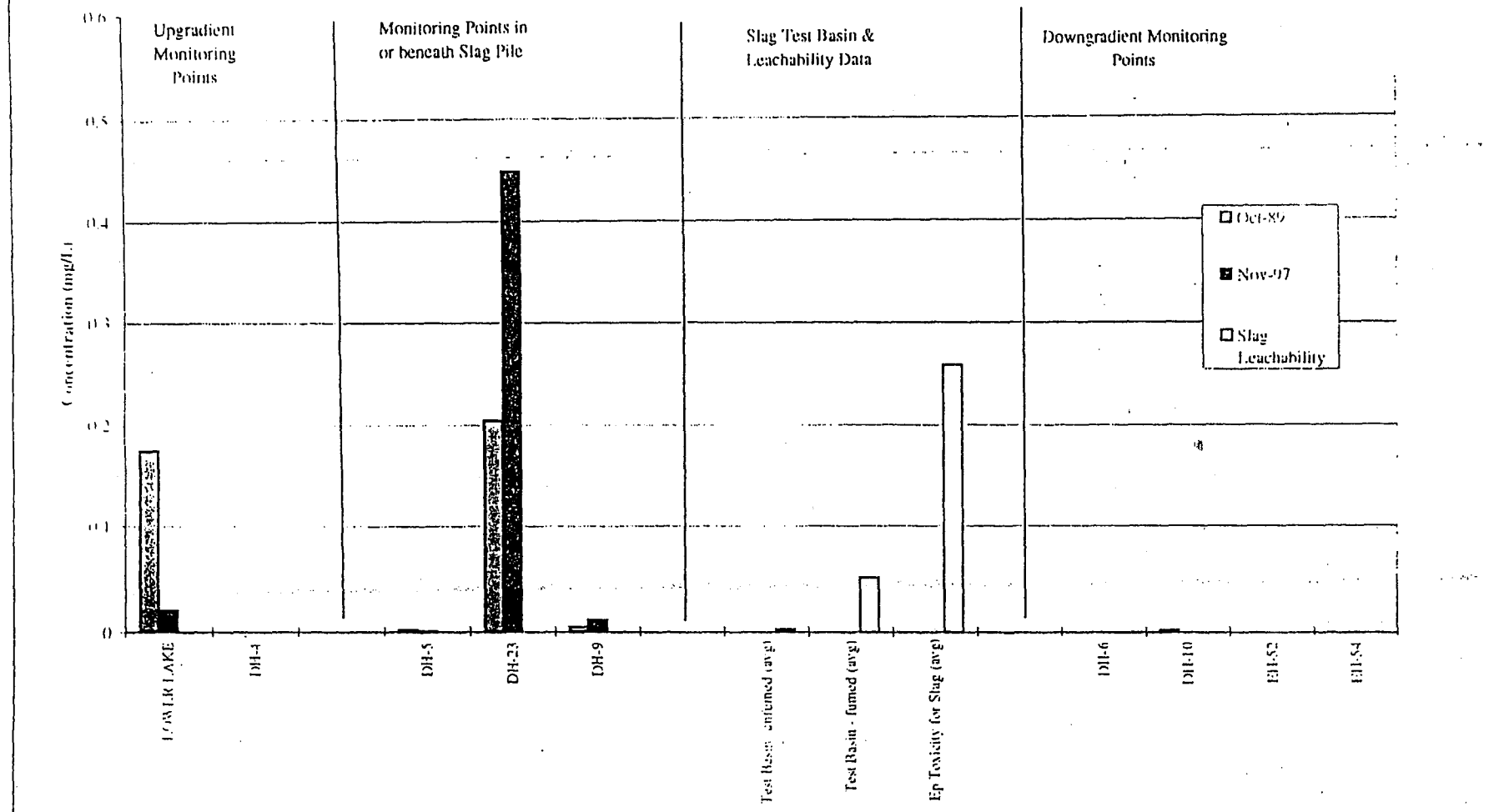


FIGURE 4-1-13. LEAD CONCENTRATION DATA FROM GROUNDWATER MONITORING WELLS IN THE SLAG PILE AREA, AND FROM SLAG TEST BASIN AND SLAG LEACHABILITY TESTING RESULTS

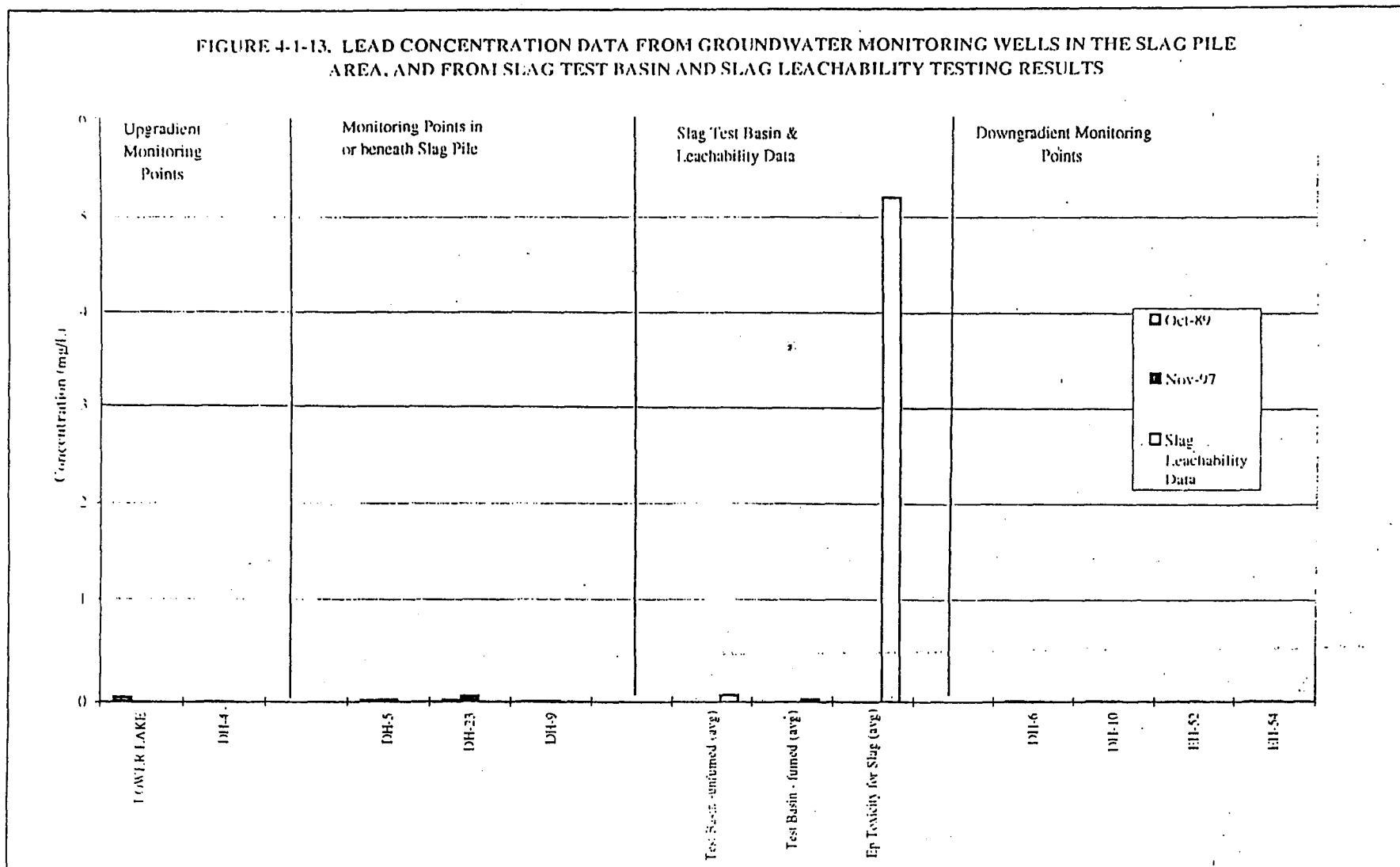
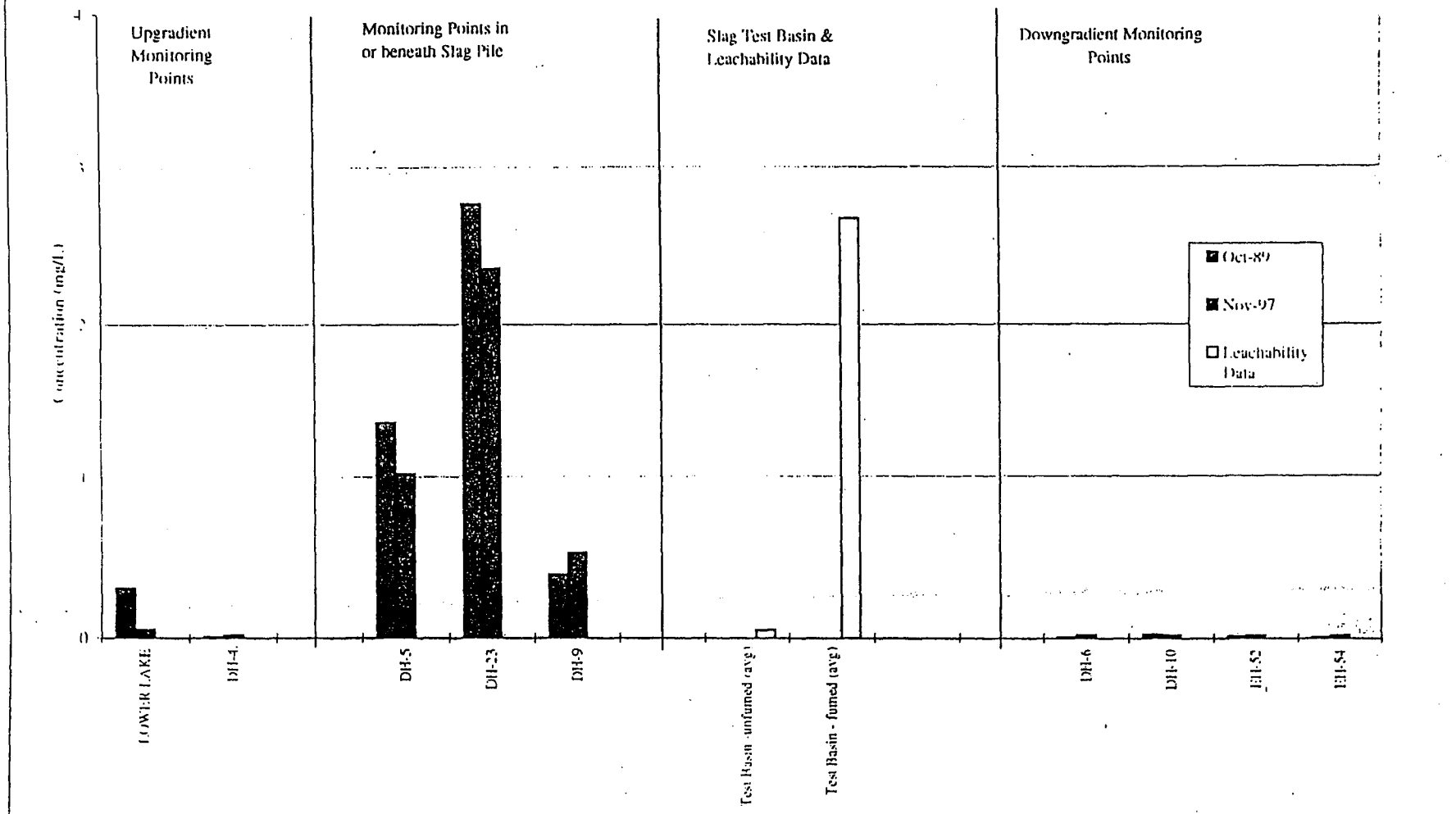


FIGURE 4-1-14. ZINC CONCENTRATION DATA FROM GROUNDWATER MONITORING WELLS IN THE SLAG PILE AREA, AND FROM SLAG TEST BASIN AND SLAG LEACHABILITY TESTING RESULTS



**FIGURE 4-1-15. CALCULATED ARSENIC LOADING FROM SLAG VS
ARSENIC LOAD IN DOWN-GRADIENT GROUNDWATER**

Data Source	Arsenic Conc.(1)	Arsenic Load (2)	% of GW Load (3)
Test Basin Data			
Fumed Slag	0.036 mg/L	0.003 lb/day	0.20%
Unfumed Slag	0.53 mg/L	0.044 lb/day	2.40%
Average	0.28 mg/L	0.022 lb/day	1.30%
Max	0.59 mg/L	0.047 lb/day	2.60%
EP toxicity (avg. of 18 tests)	0.16 mg/L	0.013 lb/day	0.70%
Groundwater Load	2.13 mg/L (4)	1.8 lb/day (4)	

Notes

(1) Source RI/FS Appendix 6-1

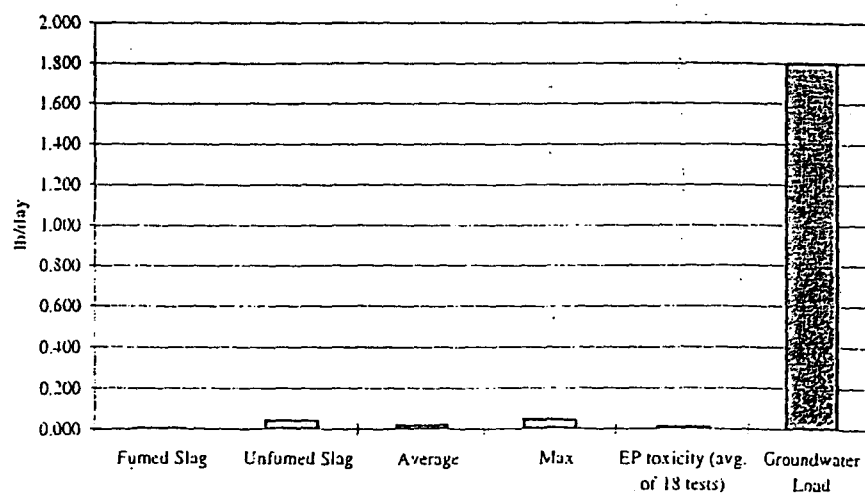
(2) Slag load calculations assume:
20% infiltration (slag test basin average)
11.3 in/yr ppt
57 acre slag pile area

(3) Calculations based on 1.8 lb/day GW arsenic load assuming:
east side groundwater flux of 70 gpm
east side groundwater arsenic concentration of 2.13 mg/L

(4) Groundwater Load assumptions
Groundwater As Concentration 2.13 mg/L (avg from DH-10)
Groundwater flux = 70 gpm

(K:\DATA\PROJECT\0867\WQ.XLS)

Arsenic Load



zinc is also very low. Based on the results of test basin water quality analyses, bottle roll tests, and down gradient groundwater quality, it is unlikely that slag effects observed groundwater quality trends on the site.

Stratigraphic cross-sections showing the slag pile and underlying stratigraphy (Figure 4-1-16) shows the relationship of the slag pile and underlying strata, including the perched alluvial horizon and the underlying coarser grained alluvial aquifer. Based on monitoring well stratigraphy, it is likely the perched horizon at least partially underlies the slag pile. However, there is no evidence of the perched horizon in downgradient wells (see DH-6 and DH-10). As a result, direct impacts from the slag pile at these wells is unlikely since the perched horizon is absent, and the wells are completed in the coarse grained alluvium. However, as noted above, test basin and laboratory test results indicate potential water quality impacts from the slag are low and are not responsible for the water quality concentration observed in downgradient wells.

4.1.4.2 Potential Surface Water Impacts

The potential for runoff transport in the slag pile area is very low due to the coarse, granular nature of the slag pile, which allows extremely rapid infiltration. Even during high precipitation events no runoff has been observed from the slag pile. Similarly seeps from the face of the slag pile have not been observed. The potential for impacts to surface water are, therefore, limited to direct contact and erosion of the slag pile where it forms steep sided banks adjacent to Prickly Pear Creek. Prickly Pear Creek is in immediate contact with the slag pile between PPC-5 and PPC-6, and adjacent to the slag pile from PPC-6 to PPC-7 (see Exhibit 3-2-1).

The 1990 Comprehensive RI/FS (Hydrometrics, 1990a) examined water quality data from Prickly Pear Creek to assess the potential impact of the slag pile on the creek. No consistent concentration or load increases were apparent in Prickly Pear Creek adjacent to the slag pile (between PPC-5 and PPC-7). The RI/FS therefore concluded that the contribution of arsenic and metals to surface water from slag is very minor. RI/FS and Post RI/FS water quality data

for Prickly Pear Creek are presented and discussed in Section 4.3 of this report and post-RI/FS water quality data are generally consistent with the RI/FS findings. Average metal concentrations show only small differences between stations PPC 5, PPC 7 and PPC 8 (see Figure 4-1-17). Only one high flow stream event (May 1994) shows a pronounced increase in total arsenic load between PPC-5 and PPC-7 (see Figure 4-3-9 in Section 4.3); however, arsenic concentrations decreased from PPC-5 to PPC-7 in the May 1994 event. The calculated load increase is therefore entirely a function of the flow measurement. Since the accuracy of the flow measurements is poor during higher flow events due to increased velocities and turbulence (particularly at PPC-5 below the dam) the apparent load increase during May 1994 is probably the result of flow measurement error. The conclusion of the surface water analysis is that there is little evidence for transport of arsenic and metals from the slag pile with the possible exception being direct erosion of the slag during infrequent high stream flow events.

4.24.2 PROCESS FLUIDS

As part of the Comprehensive RI/FS (Hydrometrics 1990a), the Process Fluids Operable Unit was divided into two sub-units: Process Ponds and Process Fluid Transport Circuits.

4.14.2.1 Process Ponds

The Process Ponds include:

- Lower Lake;
- Former Thornock Lake, and
- The acid plant water treatment facility.

As described in Sections 1 and 3, the Process Ponds were addressed by the Process Ponds RI/FS (Hydrometrics, 1989), a subsequent Process Ponds ROD (US EPA, 1989), and several RD/RA documents, and remedial actions that consisted primarily of sediment excavation. The 1989 Process Pond RI consisted of:

ASARCO TECHNICAL SERVICES CENTER

ANALYTICAL DATA REPORT

East Helena

Technical Services (Project 3101)

Batch No: L010790

LAB NO	DATE COLLECTED	DESCRIPTION	PARAMETER	VALUE	UNITS	ANALYST	DATE ANALYZED	HOLD DAYS	METHOD
L010790-002	23-MAY-01	FUMED ASARCO SLAC	AG	0.003	%	MJF	18-JUN-01		ICP
			AL	2.32	%	MJF	18-JUN-01		ICP
			AS	0.022	%	MJF	19-JUN-01		ICP
			BA	0.34	%	MJF	18-JUN-01		ICP
			BE	<0.02	%	MJF	18-JUN-01		ICP
			CR	0.036	%	MJF	18-JUN-01		ICP
			CU	0.32	%	MJF	18-JUN-01		ICP
			HG	2.7	ppm	MO	21-JUN-01		COLD VAPOR AA
			MN	1.37	%	MJF	18-JUN-01		ICP
			NI	<0.02	%	MJF	18-JUN-01		ICP
			PD	0.036	%	MJF	19-JUN-01		ICP
			SD	0.026	%	MJF	18-JUN-01		ICP
			SE	<0.02	%	MJF	18-JUN-01		ICP
			TL	<0.02	%	MJF	18-JUN-01		ICP
			V	<0.02	%	MJF	18-JUN-01		ICP
			Zn	1.63	%	MJF	18-JUN-01		ICP

ASARCO TECHNICAL SERVICES CENTER

ANALYTICAL DATA REPORT

East Helena

Technical Services (Project 3101)

Batch No: L010791

LAB NO	DATE COLLECTED	DESCRIPTION	PARAMETER	VALUE	UNITS	ANALYST	DATE ANALYZED	HOLD DAYS	METHOD
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L010791-002 23-MAY-01 FUMED ASARCO SLAG (TCLP)

AG	<0.050	ppm	ESH	08-JUN-01	6010
AS	<0.10	ppm	ESH	08-JUN-01	6010
BA	1.4	ppm	ESH	08-JUN-01	6010
BE	<0.005	ppm	ESH	08-JUN-01	6010
CD	<0.050	ppm	ESH	08-JUN-01	6010
CR	<0.10	ppm	ESH	08-JUN-01	6010
HC	<0.50	ppb	MO	07-JUN-01	7470
NI	<0.10	ppm	ESH	08-JUN-01	6010
PB	0.23	ppm	ESH	08-JUN-01	6010
PH	9.2	pH	MO	05-JUN-01	150.1
SE	<0.10	ppm	ESH	08-JUN-01	6010
TL	<0.10	ppm	ESH	08-JUN-01	6010
V	<0.10	ppm	ESH	08-JUN-01	6010
ZN	17	ppm	ESH	08-JUN-01	6010

Approved

Reviewer

APPENDIX E

EXAMPLE INSPECTION FORM

INTERIM CAP INSPECTION CHECKLIST

AREA INSPECTED	Area No.		Inspected by:	DATE:		
	ITEM NO.	CONDITION	OBSERVATION	ACTION NEEDED		
				MONITOR	INVESTIGATE	REPAIR
INTERIM LINER SYSTEMS	1	Exposed liner				
	2	Sand Bags				
	3	Liner Seams				
	4	Liner/Concrete Attachments				
	5	Site Drainage				
Additional Comments:						